AD-A073 071 TEXAS RESEARCH INST OF MENTAL SCIENCES HOUSTON F/G 6/16
ANALYSIS OF ELECTROPHYSIOLOGICAL SIGNALS FROM ANIMALS SUBJECTED--ETC(U)
AUG 79 B SALTZBERG, W D BURTON N00014-76-C-0911

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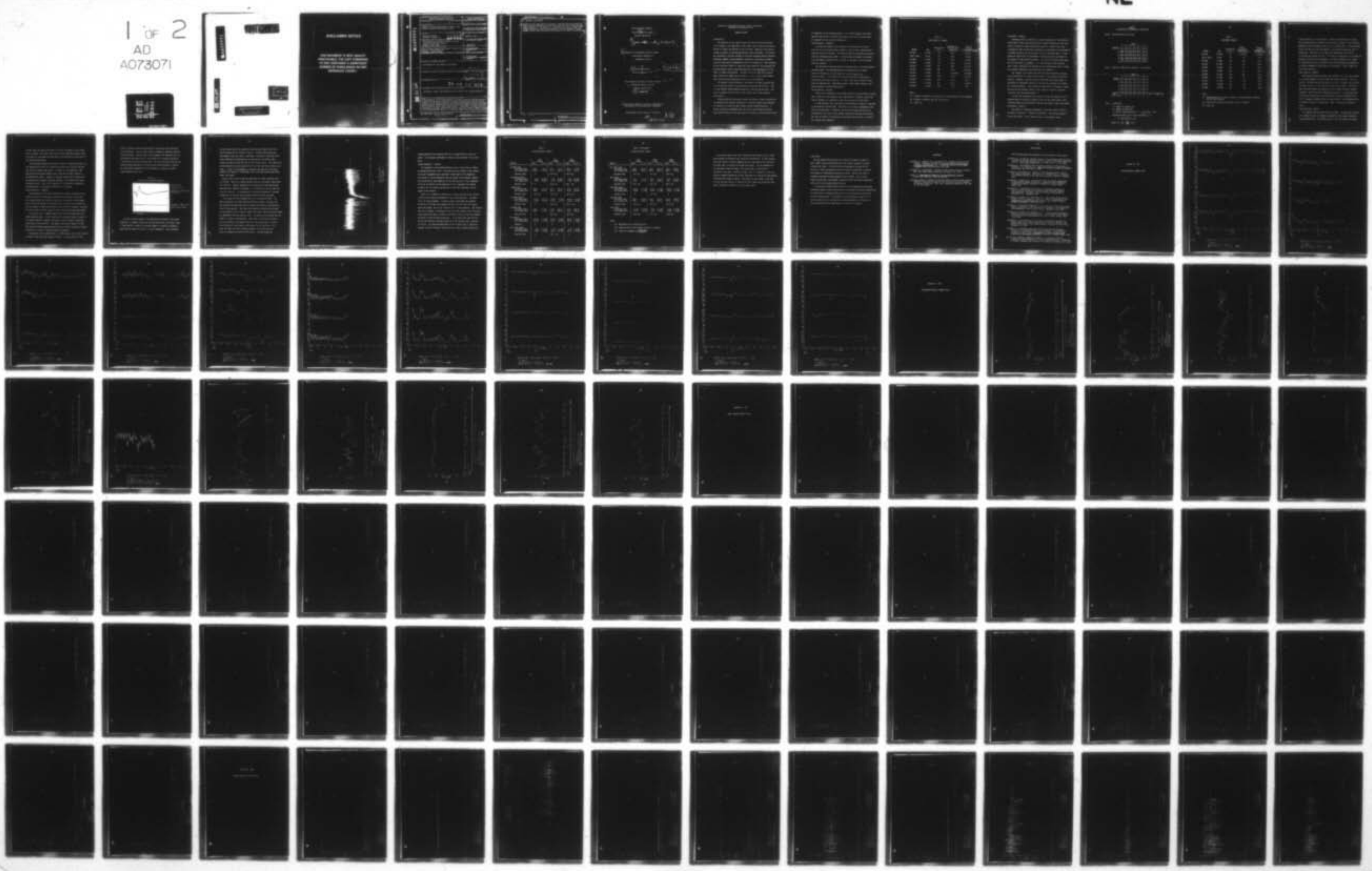

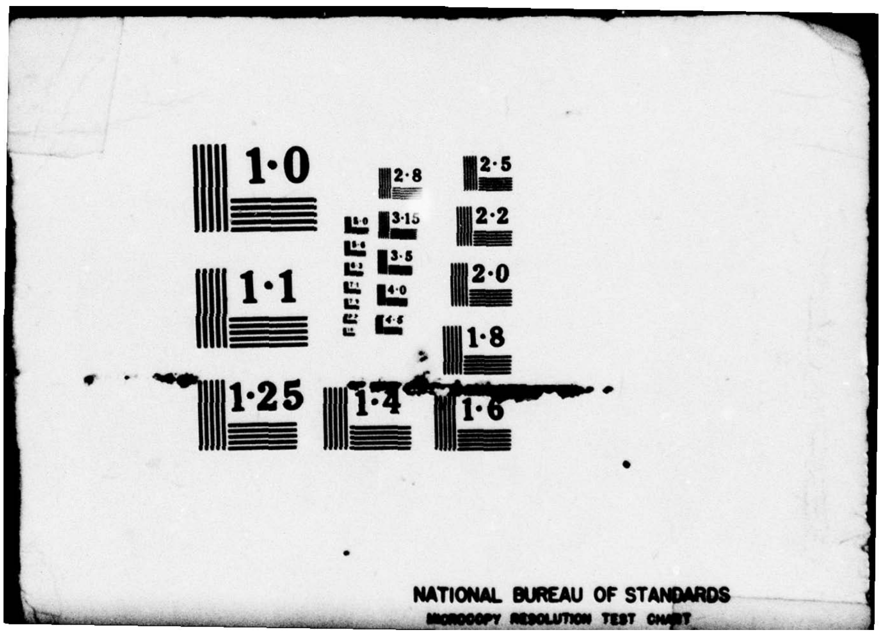
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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Analysis of Electrophysiological Signals from Animals Subjected to Biodynamic Stress

5. TYPE OF REPORT & PERIOD COVERED
Progress May 1977-July 1979

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
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Williams D. Burton, Jr.

LEVEL II

8. CONTRACT OR GRANT NUMBER(s)
N000-76-C-0911 (14)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Texas Research Institute of Mental Sciences
Information Analysis Section
Houston, Texas 77030

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
NR-207-011

11. CONTROLLING OFFICE NAME AND ADDRESS
Office of Naval Research, Biological Sciences Div.
Biophysics Program Code 444
Arlington, Virginia 22217

12. REPORT DATE
16-August-1979

13. NUMBER OF PAGES
116

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this report is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

79 08 24 018

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Biodynamic stress, electrophysiological signals, EEG, evoked potentials

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of the signal analysis and data processing reported here was to detect and evaluate the effects of impact acceleration on the functional integrity of the nervous system as revealed by electrophysiological recordings. Evoked potential methods were used to evaluate the effects of impact acceleration on afferent nerve impulse transmission. The methods of period analysis, concordance, and power spectra were used to study the effect of impact acceleration on background EEG activity. Consistent impact dose related effects were →

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S/N 0102-LF-014-6601

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract (continued)

observed on the time course of recovery of the amplitude and latency of evoked response components measured from single and small sample average evoked potentials. The analysis of background EEG activity showed clear changes between pre- and post-acceleration, but the magnitude of these changes did not show a consistent relationship to the level of acceleration.

OFFICE OF NAVAL RESEARCH

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Contract N00014-76-C-0911

Task No. NR-207-011

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PROGRESS REPORT NO. 1. May 77-Jul 79,

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Analysis of Electrophysiological Signals

from Animals Subjected to

Biodynamic Stress

by

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12 120p.

Texas Research Institute of Mental Sciences 392 821

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11 16 August 1979

S/C 392821

Analysis of Electrophysiological Signals from Animals Subjected to Biodynamic Stress

PROGRESS REPORT

Introduction:

The objective of the signal analysis and data processing performed on this project, and summarized in this report, was to detect and evaluate effects of impact acceleration on the functional integrity of the nervous system as revealed by electrophysiological (EEG) recordings. The analysis was performed on EEG data recorded at the Naval Aerospace Medical Research Laboratory (NAMRL) during biodynamic experiments using Rheusus monkeys. Using this data base a comprehensive series of analyses has been conducted at this institute (TRIMS) to study EEG evoked potential and background EEG activity before, during, and after the animals were subjected to various levels of impact acceleration. The data studied at TRIMS covers experiments conducted at NAMRL during the period January, 1975 through October, 1978, which involved acceleration runs in the -GX direction.

The methods of period analysis, concordance, and power spectrum were used to study the effect of acceleration on background EEG activity. Each of these methods showed changes between pre- and post-acceleration. However the changes did not follow a clear impact level (dose-response) relationship.

Evoked potentials were used to study the effect of impact acceleration on ascending nerve impulse transmission. Computer software was developed for analysis of single and small sample average evoked potentials. A series of analysis experiments was carried out which showed consistent dose related effects on the time course of recovery of amplitude and latency

of components of the evoked potential. This finding suggests that these measures may provide a reliable quantitative basis for assessing effects of biodynamic stress on nerve transmission.

Period Analysis - Methods:

Four EEG data channels were digitized from analog tape to 10-bit precision at 2 millisecond sample intervals using an AR-11 analog digital converter on PDP-11 computer. The digitized data was analyzed using period analysis (Saltzberg et al, 1966). In this method the number of both positive and negative going baseline crossings of the data in each 10-second epoch was counted.

The resulting 10 second counts were smoothed using a 1-minute (6-epoch) running average. The smoothed counts were plotted for each channel. Figures A1 through A11 are the plots for the experimental runs listed in Table 1. The time of the acceleration event is indicated on the plots by an arrow at time 0.0. In order, from top to bottom in these plots the channels are: Right Motor-Sensory, Right Sensory-Sensory, Left Sensory-Sensory, and Left Motor-Sensory.

Period Analysis - Results:

Table 1 also indicates 1) the average reduction in the baseline crossing rate, relative to the pre-event rate, averaged over 4 channels, and 2) the time to recovery of variability in the rate, measured from the plots.

In the non-fatal runs, the effect of acceleration is shown as a decrease in the baseline crossing rate. The effect is not clearly dependent on the level of acceleration. In general, the minute-to-minute variability of the baseline cross rate is also reduced immediately following acceleration. The time to recovery of variability as measured from the plots is likewise not strongly dose dependent.

Table 1

PERIOD ANALYSIS SUMMARY

Animal	Run	Acceleration G	Reduction in Baseline Cross Rate (1)	Time To Recovery of Variability (2)
AO-3921	LX-1364	40	0.39	2.0 min
(Rob't Rhes.)	LX-654	50	0.63	7.3 min
AO-3948	LX-1891	80	0.26	7.0 min
AO-3948	LX-1892	81	0.40	13.1 min
AO-3935	LX-1362	105	0.82	10.0 min
AO-3933	LX-1894	106	0.20	39.0 min
AO-3924	LX-1893	108	no change	no change
AO-4099	LX-1359	109.7	0.12	3.6 min
AO-3921	LX-1365	110	-(3)-	-(3)-
AO-3935	LX-1363	127	0.33	2.0 min
AO-4099	LX-1360	130	-(3)-	-(3)-

Notes:

(1) Average of reduction in crossing rate (pre-post)/pre for four channels

(2) Average of recovery time for four channels

(3) Fatal run

Concordance - Methods:

Saltzberg (1975) proposed that a running computation of the Kendall-W Coefficient of Concordance would provide a dynamic indication of the time course of similarity among multiple EEG channels. Based on this idea, a program has been written which implements the computation of the Kendall-W including correction for the presence of ties in the input data. In computing the coefficient of concordance, the input data for each epoch in the window is ranked (within channels). The sum of the ranks across channels for each epoch is computed. It is the variance of the resulting sum of ranks, compared to the maximum variance (which would occur if there were complete agreement) which determines the Kendall-W.

Four channels of EEG data were digitized and the baseline crossing rate was determined for each 10 second epoch of each channel (see Period Analysis - Methods). Each EEG channel (excluding the stimulus mark) is considered an independent measurer of the EEG over a window of 3 minutes (18, 10-second epochs). The concordance computation is arranged to report how well the EEG channels agree in their ranking of activity (baseline crossings) over the window (Figure 1).

To track the concordance over a period of time, the Kendall-W is recomputed every 10 seconds by deleting data from the oldest epoch in the 3 minute window and inserting data from the next epoch to enter the window.

Concordance - Results:

The results of computing concordance on the data listed in Table 2 are shown in the plots. Figures B1 through B11. The following general results were noted. First, that the level of concordance varies

FIGURE 1
ILLUSTRATION OF CONCORDANCE COMPUTATION

Step A. Raw Data-Baseline Crossings

Channel	Epoch 1	2	3	4	5	6
1	20	25	23	26	28	30
2	18	19	20	21	22	23
3	17	16	15	18	19	20
4	22	26	23	28	30	29

Step B. Ranking of Data within channels, across epochs

Channel	Epoch (j) 1	2	3	4	5	6	
1	1	3	2	4	5	6	
2	1	2	3	4	5	6	
3	3	2	1	4	5	6	
4	1	3	2	4	6	5	
Sum of Ranks (R_j)	6	10	8	16	21	23	$14 = \overline{R} = \text{Mean}\ (R_j)$

Step C. Computation

k = number of channels (4)

N = number of epochs (6)

s = sum of squared deviations $s = \sum_{j=1}^{N} (\overline{R}-R_j)^2 = 250$

Maximum possible sum of squared deviations = M

$$M = \frac{1}{12} k^2(N^3-N) = 280$$

$$\text{Kendall } W = \frac{s}{M} = \frac{250}{280} = 0.89$$

Table 2

CONCORDANCE SUMMARY

Animal	Run	Acceleration (G)	Maxium Concordance Reduction (1)	Time To Recovery (Minutes) (2)
AO-3921	LX-1364	40	no effect	no effect
(Rob't Rhes.)	LX-654	50	.70	7.4
AO-3948	LX-1891	80	.38	7.5
AO-3948	LX-1892	81	.58	14.9
AO-3935	LX-1362	105	.47	6.7
AO-3933	LX-1894	106	.53	10.5
AO-3924	LX-1893	108	.46	9.1
AO-4099	LX-1359	109.7	.58	10.9
AO-3921	LX-1365	110	-(3)-	-(3)-
AO-3935	LX-1363	127	.55	5.0
AO-4099	LX-1360	130	-(3)-	-(3)-

Notes:

(1) Maximum Reduction in value of Kendall-W following impact relative to pre-impact average.

(2) Time to first return to pre-impact level of Kendall-W

(3) Fatal run

in most animals in a cyclic fashion. Second, that the onset of a stimulation period appears to affect the concordance in either of two directions depending on the concordance level prior to stimulus onset. For concordance values less than 0.5, the concordance is increased following the start of stimulation. The effect is to reduce the concordance if the initial concordance was greater than 0.5. The effect of acceleration is an immediate decrease in the level of concordance. The effect continues for a number of minutes but the time of recovery to the pre-acceleration concordance is not clearly dependent on the amount of acceleration. Table 2 summarizes the results obtained.

Power Spectrum - Methods:

Power Spectral Densities (PSDs) were computed on all four EEG channels for selected segments of tape LX-1894 106G (Subject AO-3933). For this analysis, 10 second epochs were taken 10 minutes, 5 minutes, and 30 seconds pre-impact and 1, 2, 5, 10, 20 and 30 minutes after impact. The analog data from each channel was sampled at 10 millisecond intervals (Nyquist Frequency = 50 Hz) using the Time/Data-100 computer. The computed power spectra were transferred to the PDP-11 where they were smoothed using a 0.5 Hz triangular weighted filer, and then plotted. The smoothed spectra are shown in Figures C1 through C36. Power is reported in arbitrary units.

Power Spectrum - Results:

All channels show an effect following impact. The PSD shows the bulk of its power at very low frequency immediately after impact compared to the pre-impact PSDs. This effect persists until 30 minutes post-impact,

by this time, the shape of the PSD is virtually identical to that found prior to impact. This most clearly seen in the Right Motor-Sensory lead. This result is consistent with the drop in the baseline crossing rate at the time of acceleration.

The Left Sensory-Sensory lead shows "ripples," separated by about 2 Hz. This begins with the PSD at 2 minutes post-impact and continues through the PSD at 20 minutes post impact. A ripple is also suggested in the data from the Left Motor-Sensory lead in the period from 2 minutes to 20 minutes post impact. Ripples in the power spectrum are indicative of the presence of recurrent transients imbedded in the complex EEG signal (Saltzberg, 1976). The ripple frequency of 2 Hz implies an underlying transient which is recurring at intervals of 0.5 seconds.

Evoked Potentials - Methods:

Evoked potentials (EPs) were obtained from monkeys stimulated in the spinal cord while simultaneously recording from the motor cortex (MX). The stimulus marker was used to trigger data acquisition at high sample rates from the MX channel of the analog tape. The data was digitized for 50 milliseconds following the stimulus using the PDP-11 computer, digitized EPs were written on digital tape for later averaging and peak measurements.

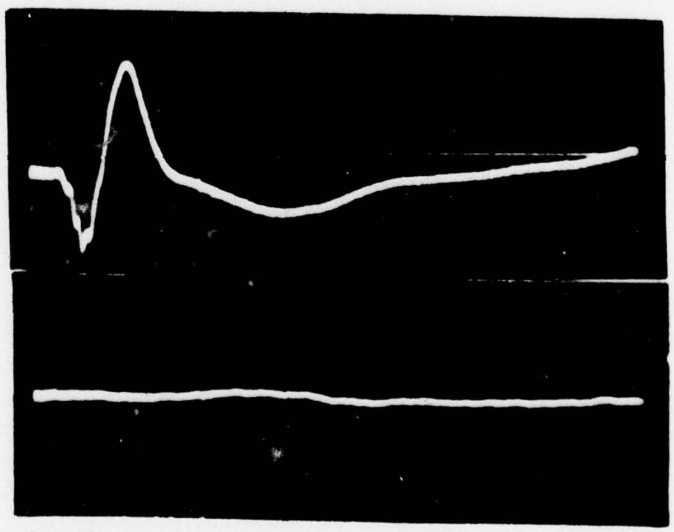
In an early trial, a sample interval of 0.125 milliseconds was used (8000 samples/second). It was found that the measured latency of peaks in the evoked potentials showed no variability prior to impact, indicating insufficient time resolution. The sample interval was reduced to 0.050 milliseconds (20,000 samples/second) which was found to preserve pre-impact variability in latency of evoked potential components.

Acceleration runs LX-3008 (20 GX), LX-3009 (80 GX), and LX-3010 (100 GX) on animal A-0761 have been studied in detail. It was possible in this

animal to detect single evoked potentials from the MX lead from spinal cord stimulation. Figure 2 shows typical averaged EP waveforms obtained from this animal. The top trace is the average of 25 responses prior to acceleration the bottom trace is the average of 25 responses beginning 1 second after the 100 GX acceleration. For the following discussion the negative-going component occurring at about 10 milliseconds is labeled N1, the positive component at 20 milliseconds is labeled P; and the longer negative wave is N2.

Figure 2

Typical Average Evoked Potential



Run LX-3010

Average of 25

Channel 1, Motor Corte
Pre impact

Channel 1, Motor Corte:

Post 100 GX impact

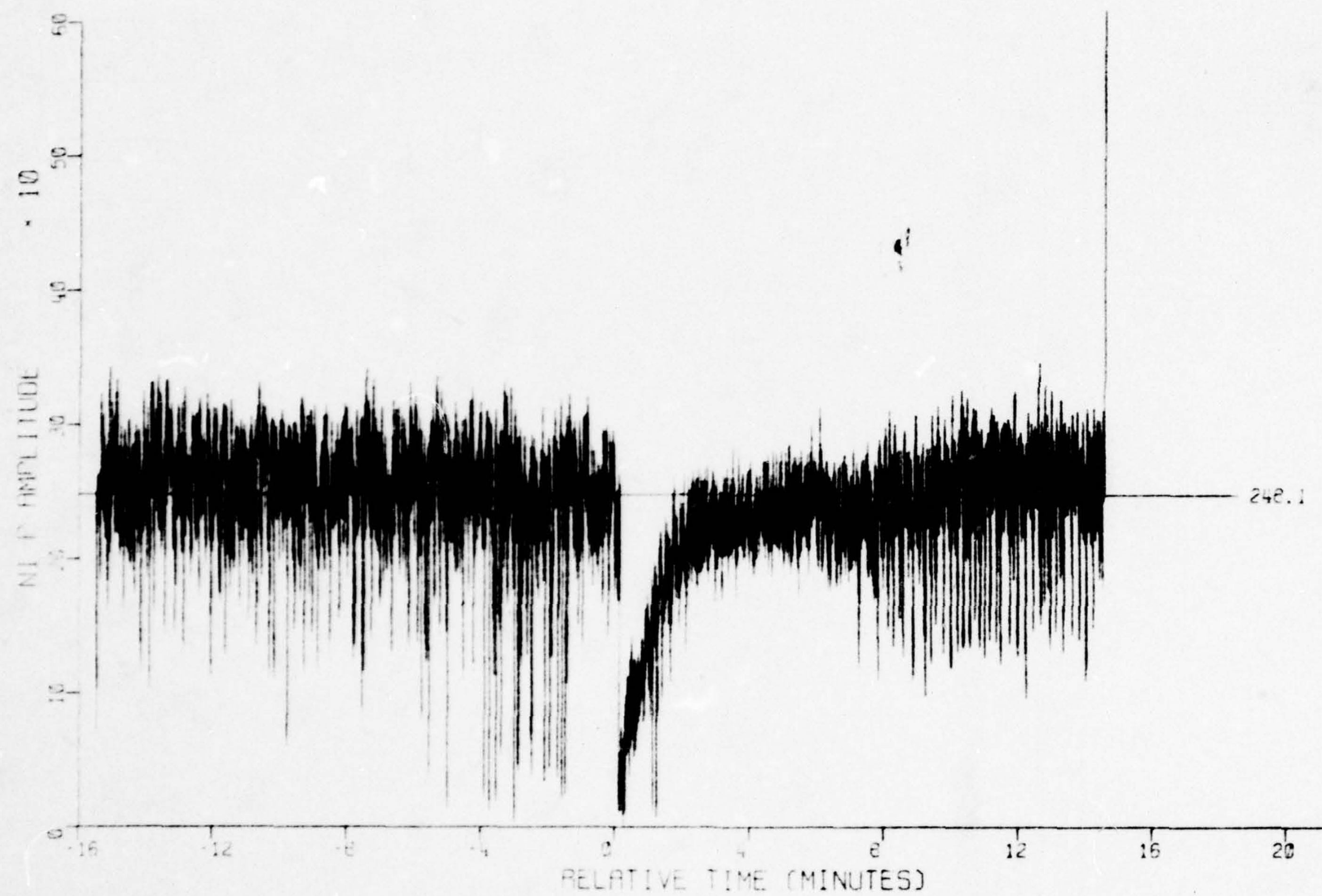
10 msec

In order to track changes in the amplitude and latency of the evoked potentials, a computer program was written which would read digital tapes of digitized EPs, average a selectable number of responses and measure amplitude and latency of the N1, P, and N2 components. After averaging

the zero level was set by subtracting the mean amplitude of the first 5 milliseconds from all points of the EP. Component amplitudes were referenced to this zero level. Amplitude is reported in arbitrary units since calibration information was not available on the analog tapes. Latency was measured from the fall of the stimulus pulse. The program also derived measures of peak-to-peak (N1-P, and P-N2) amplitude, latency, and slope. A total of 12 parameters is therefore measured for each evoked potential (3 latencies, 3 amplitudes, and 2 each peak-to-peak amplitudes, times, and slopes).

Figure 3 shows a plot of the N1-P amplitude for single responses from run LX-3010. There is a clearly defined effect of the impact acceleration (at time 0.0). However, because of the variability of the peak-to-peak amplitude from response to response, it is difficult to resolve the time course of recovery. To overcome this, and enable estimation of response variability, an analysis using average evoked potentials was made.

Five single EPs were averaged to create an Average EP (AEP). The twelve parameters were then measured from each average. Measures from ten successive averages were used to compute the mean and standard deviation for each measure. Each mean thus computed represented an estimate of the parameter over an epoch of about 10 seconds, (the actual epoch length was determined from the stimulus rate). The measures were plotted and are shown in Figures D1 through D36. Times shown in the plots and Table 3 are to the center of the epoch relative to the impact event. The mean of each measure in each epoch is the center line in the plots. The upper and lower plot lines indicate envelope of the mean plus and minus one standard deviation for that epoch. The grand mean and



ANIMAL A-0761 RUN LX-3010 ACCELERATION 100.0 G
STIMULUS SITE 5. AFFER, RATE 5.0 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 1

FIGURE 3

standard deviation for measures from all pre-impact AEPs was also computed. The pre-impact grand mean is shown as the horizontal line on the plots.

Evoked Potentials - Results:

All parameters of the evoked potential show a clear effect on impact at accelerations above 20 G. The effects are an increase in the latency of N1 and P components and a decrease in amplitude of all components. The latency of the N2 components does not appear to be affected, however, this may be due to poor detection of the true position of that component. At the 20 G acceleration the amplitude of the P component was reduced slightly, but its latency and measures on the other components did not appear to be affected.

Table 3 is a summary of the effects of impact acceleration at various G levels on the measured parameters of the evoked potential. The table lists, for each parameter: 1) the pre-impact grand mean and standard deviation, 2) the mean and standard deviation for the first (10 second) epoch post-impact, and 3) the "recovery time" of the parameter. The recovery time for a parameter is defined as the time to the center of the first post-impact epoch whose mean is within an envelope of plus or minus one standard deviation of the pre-impact grand mean. If the epoch mean does not fall outside this envelope following impact then the recovery time is defined to be zero. The detailed measurement of the recovery time is made from computer printed listings of epoch statistics (mean, standard deviation).

Table 3

Evoked Potential Summary

Measure	20G LX-3008 mean	(s.d.)	80G LX-3009 mean	(s.d.)	100G LX-3010 mean	(s.d.)
N1 Amplitude						
Pre-impact mean	-112.2	(6.5)	-111.1	(6.7)	-103.8	(6.9)
First epoch post	-113.1	(6.0)	- 71.8	(44.4)	- 76.8	(41.7)
Recovery time	0		127.8 sec		251.0 sec	
N1 Latency (msec)						
Pre-impact mean	9.44	(0.06)	9.24	(0.06)	9.02	(0.06)
First epoch post	9.42	(0.06)	9.75	(0.57)	9.35	(2.35)
Recovery time	0		158.6 sec		>866. sec	
P Amplitude						
Pre-impact mean	146.4	(28.7)	151.1	(29.1)	139.8	(27.8)
First epoch post	95.4	(11.5)	66.9	(53.2)	83.8	(47.0)
Recovery time	35.2 sec		97.0 sec		107.3 sec	
P Latency (msec)						
Pre-impact mean	17.10	(0.37)	16.64	(0.36)	16.30	(0.25)
First epoch post	17.00	(0.31)	23.70	(7.10)	19.49	(8.61)
Recovery time	0		66.2 sec		497.2 sec	
N2 Amplitude						
Pre-impact mean	- 74.2	(11.4)	- 79.0	(11.7)	- 71.5	(12.8)
First epoch post	- 60.7	(8.8)	- 32.0	(38.0)	- 54.0	(29.1)
Recovery time	0		168.9 sec		189.0 sec	
N2 Latency						
Pre-impact mean	43.92	(3.32)	43.71	(2.58)	42.57	(2.41)
First epoch post	41.74	(3.04)	44.15	(2.35)	42.30	(4.60)
Recovery	0		0		0	
N1-P time (msec)						
Pre-impact mean	7.66	(0.37)	7.40	(0.36)	7.37	(0.26)
First epoch post	7.54	(0.30)	13.91	(6.77)	10.14	(6.76)
Recovery time	0		25.2 sec		0	

Table 3 (continued)

Evoked Potential Summary

Measure	20G LX-3008 mean	(s.d.)	80G LX-3009 mean	(s.d.)	100G LX-3010 mean	(s.d.)
N1-P Amplitude						
Pre-impact mean	258.6	(30.0)	262.2	(31.2)	243.7	(30.1)
First epoch post	208.5	(10.3)	138.7	(96.5)	160.7	(8.8)
Recovery time	35.2 sec		97.0 sec		138.1 sec	
N1-P Slope						
Pre-impact mean	33.7	(3.1)	35.4	(3.5)	33.5	(3.8)
First epoch post	27.6	(1.1)	16.3	(14.0)	21.7	(12.5)
Recovery time	35.2 sec		138.1 sec		400.1 sec	
P-N2 Time (msec)						
Pre-impact mean	26.82	(3.12)	27.97	(2.40)	26.27	(2.32)
First epoch post	24.78	(2.99)	20.49	(5.36)	22.81	(7.70)
Recovery time	0		25.2 sec		0	
P-N2 Amplitude						
Pre-impact mean	220.7	(27.9)	230.1	(30.2)	221.4	(28.0)
First epoch post	156.1	(10.9)	98.9	(79.6)	137.9	(7.3)
Recovery time	35.2 sec		168.9 sec		353.6 sec	
P-N2 Slope						
Pre-impact mean	-8.26	(0.85)	-8.50	(0.88)	-8.06	(0.93)
First epoch post	-6.37	(0.72)	-4.21	(2.91)	-1.90	(0.72)
Recovery time	45.4 sec		179.2 sec		363.8 sec	

Notes:

(1) Amplitudes are in arbitrary units

(2) Latencies are in milliseconds relative to stimulus

(3) Slopes are computed as $\frac{\Delta \text{ Amplitude}}{\Delta \text{ Latency}}$

The recovery times of N1, and P amplitudes and latencies show a clear dose-response relationship with increasing acceleration. At 100 G acceleration the latency of the N1 component has not recovered by the end of the available data, 14 minutes 26 seconds post impact. The N2 component was not measurably affected, however this may be due to uncertainty in detection of the peak. Visible in Figure D 27 is a reduction in the variability (standard deviation) of the P amplitude for a period of approximately 10 minutes post impact at 100 G. This effect is not visible in the plot at 20 G, but does show up in the plot for 80 G where the variability takes about 4 minutes to recover to its pre-impact level.

Future Work:

We have demonstrated the ability to detect and quantify changes in small sample average evoked potentials from animals subjected to impact acceleration stress. This work should be expanded to include similar analysis of other acceleration runs with afferent stimulation to quantify EEG changes at intermediate acceleration levels. Data of this type is presently available on analog magnetic tape at TRIMS. Also, similar analysis using data, from monkeys receiving central (efferent) stimulation with spinal cord recording should be done.

In cases where single evoked potentials can be unambiguously detected, additional analysis should be directed to the problem of precisely determining the time course of changes taking place in nerve transmission during the period of acceleration. This aspect of future analytical research is of special value since it can lead to accurate measurement of the point on the acceleration profile when neural transmission is affected.

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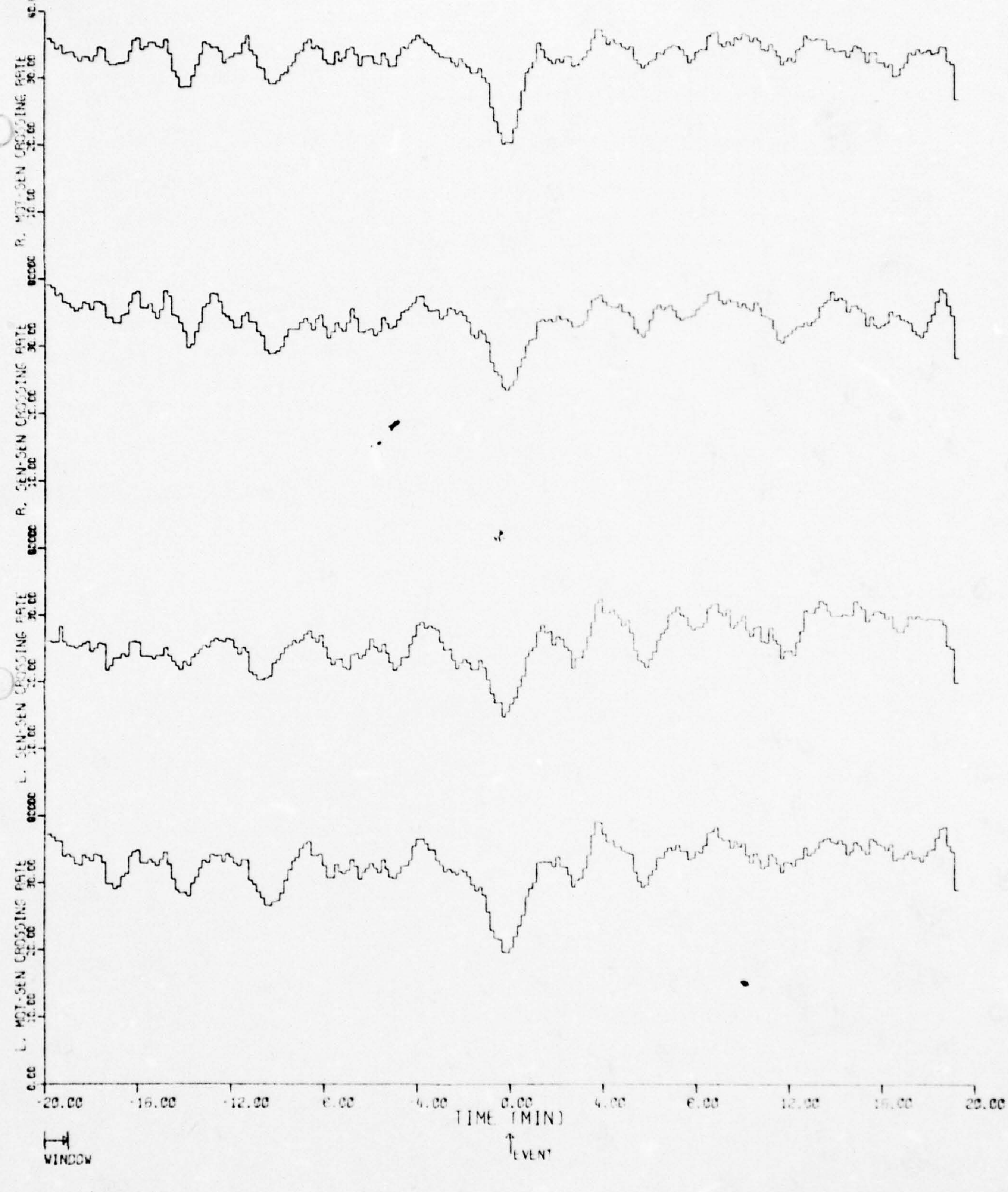
Figures A1 - A11

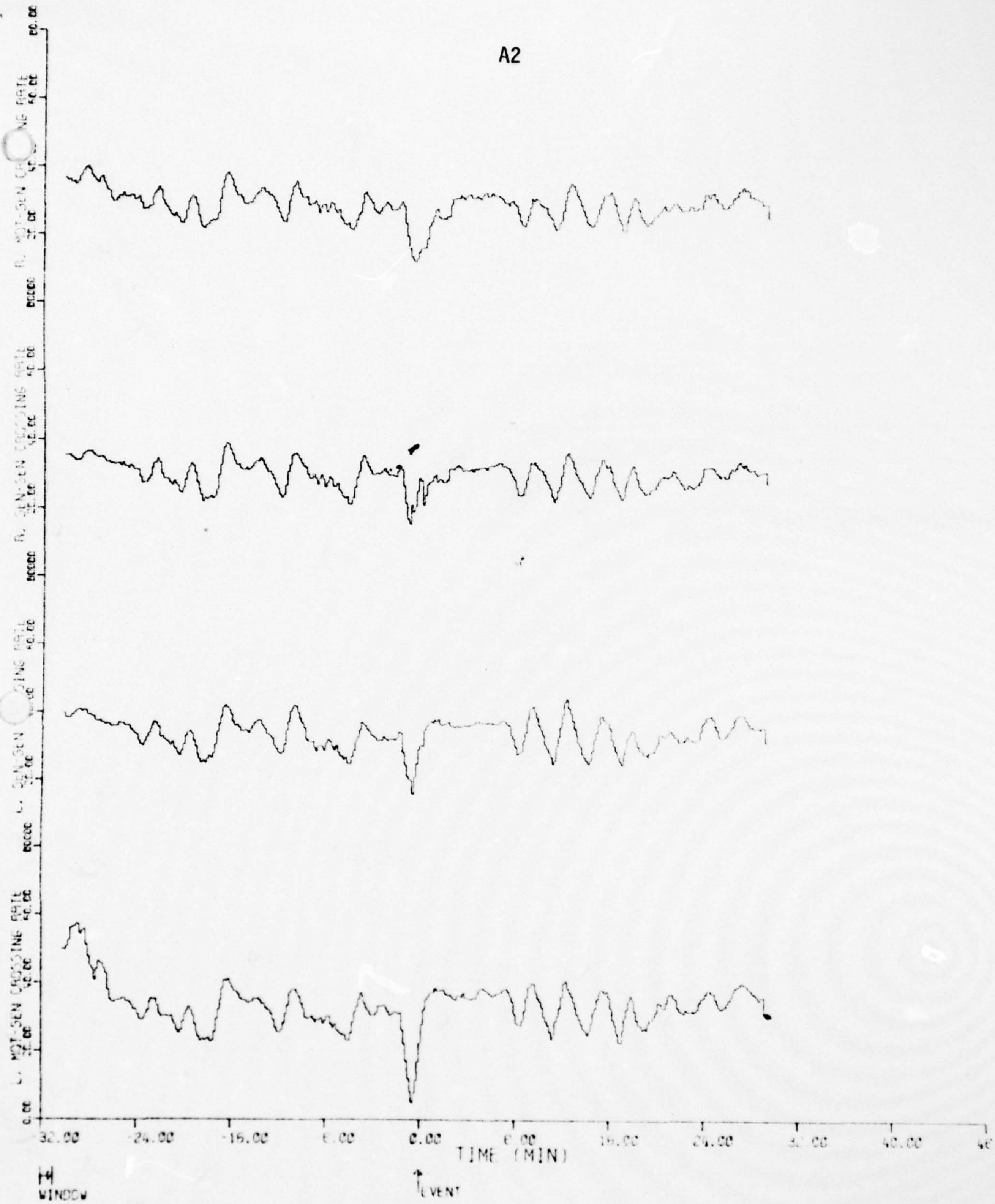
Period Analysis Summary Plots

A1



BASELINE CROSSINGS VERSUS TIME

4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A0-3921 TAPE 1364 40GX

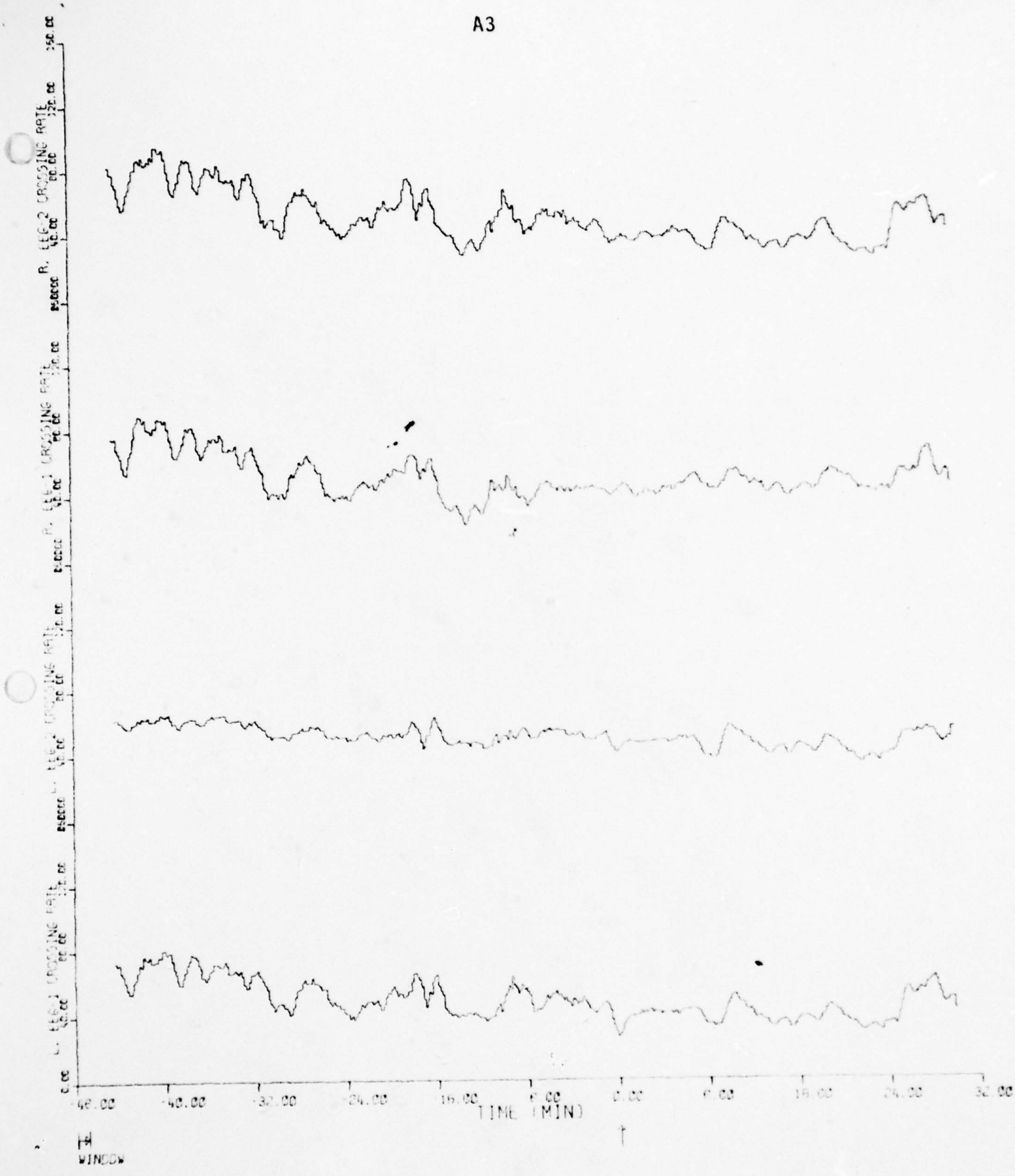


BASELINE CROSSINGS VERSUS TIME

4 CHANNELS

10. SEC EPOCHS 6 AVERAGED

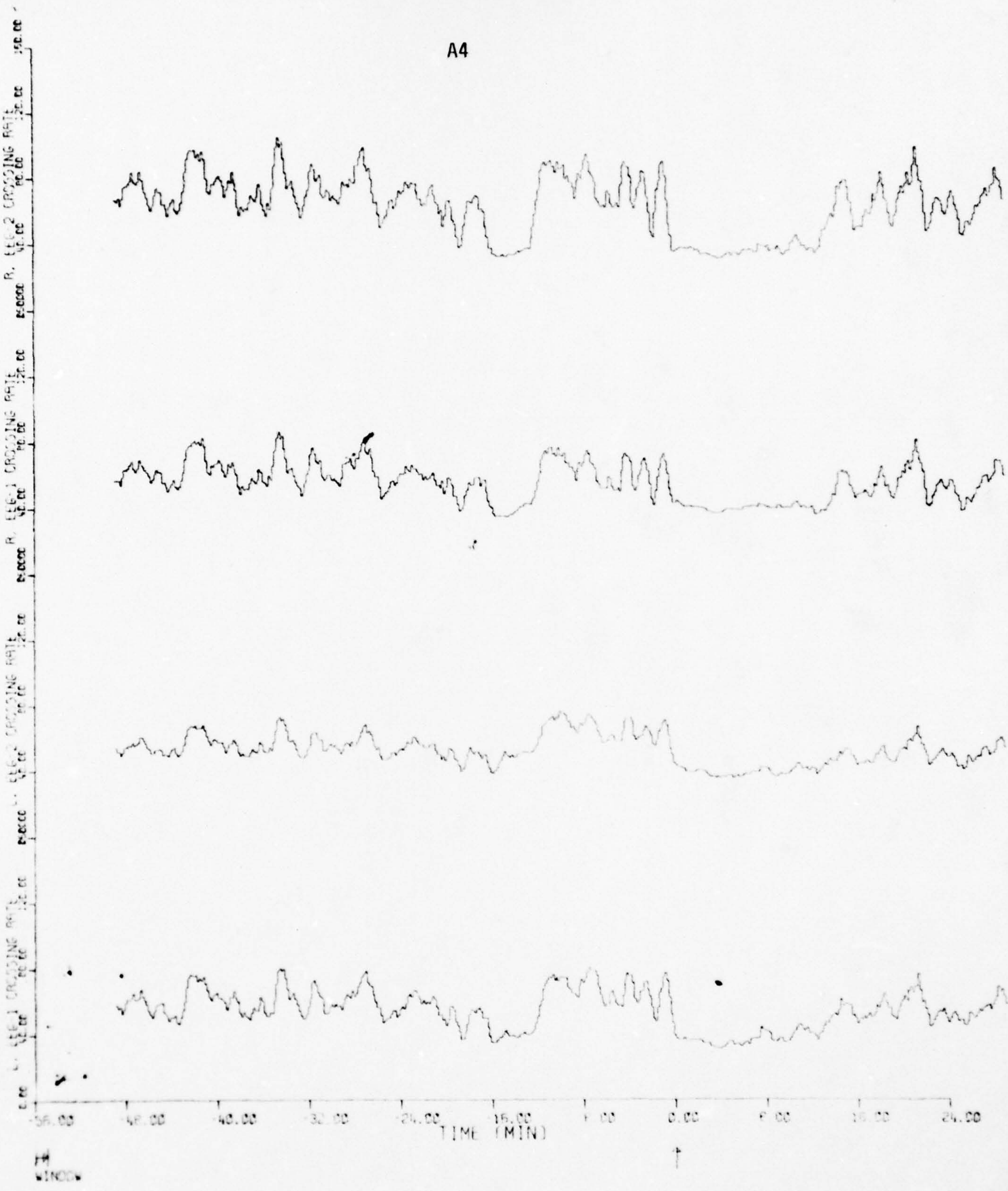
SUBJECT ROBT RHESU TAPE 654 50GX



BASELINE CROSSINGS VERSUS TIME

4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT AØ 3943 TAPE 1891 **80GX**

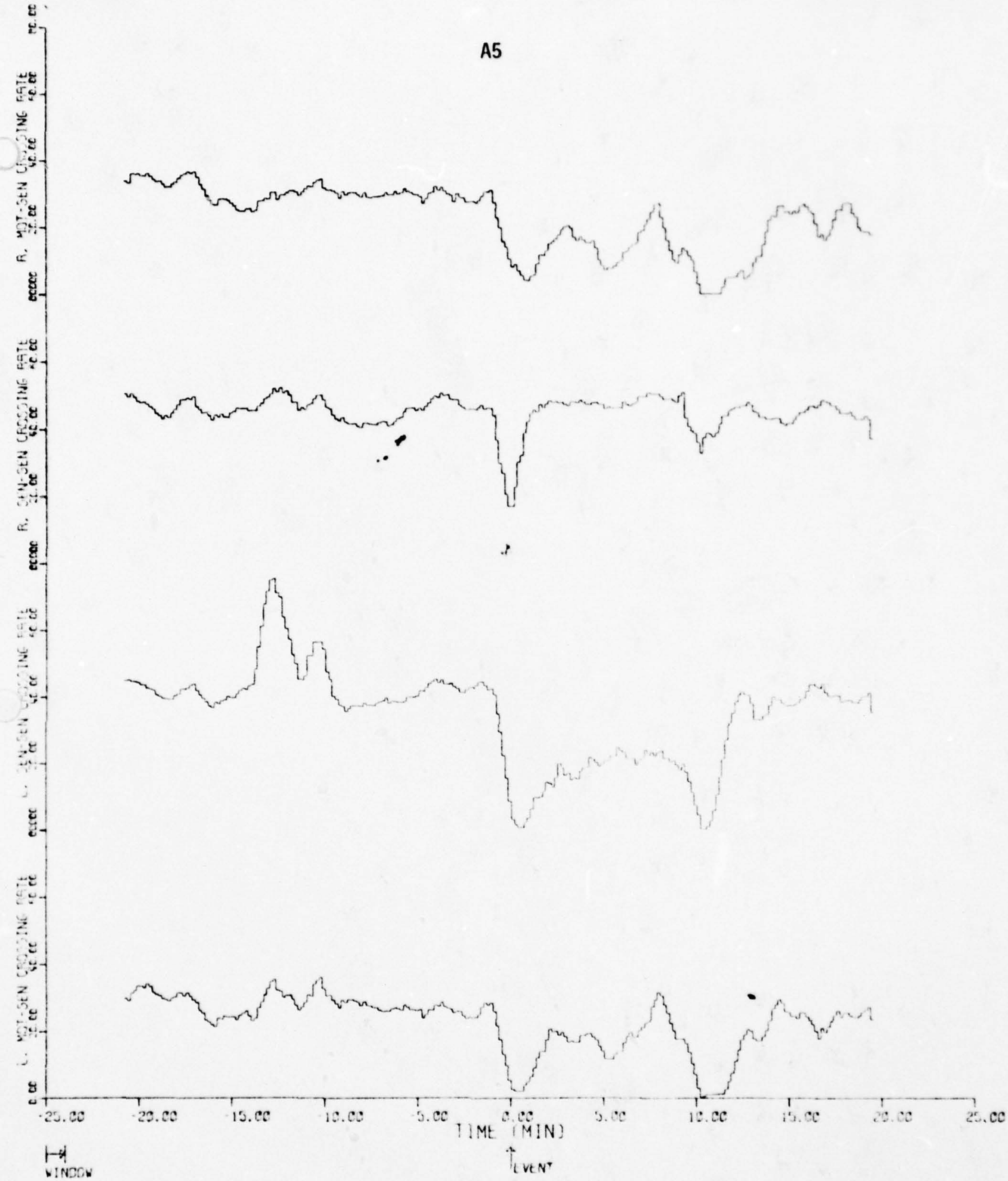
A4



BASELINE CROSSINGS VERSUS TIME

4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A0 3948 TAPE 1892 81GX

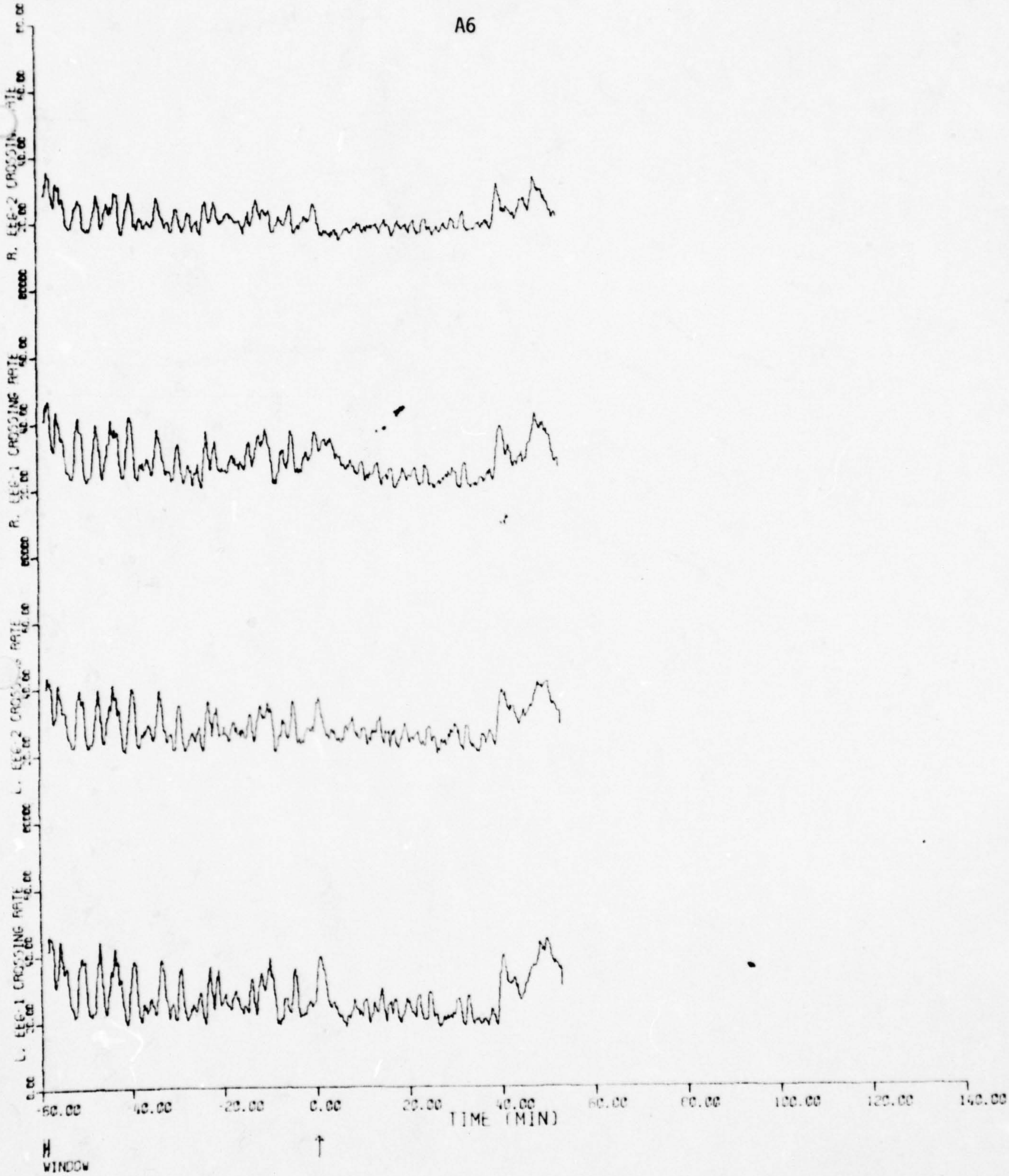
A5



BASELINE CROSSINGS VERSUS TIME

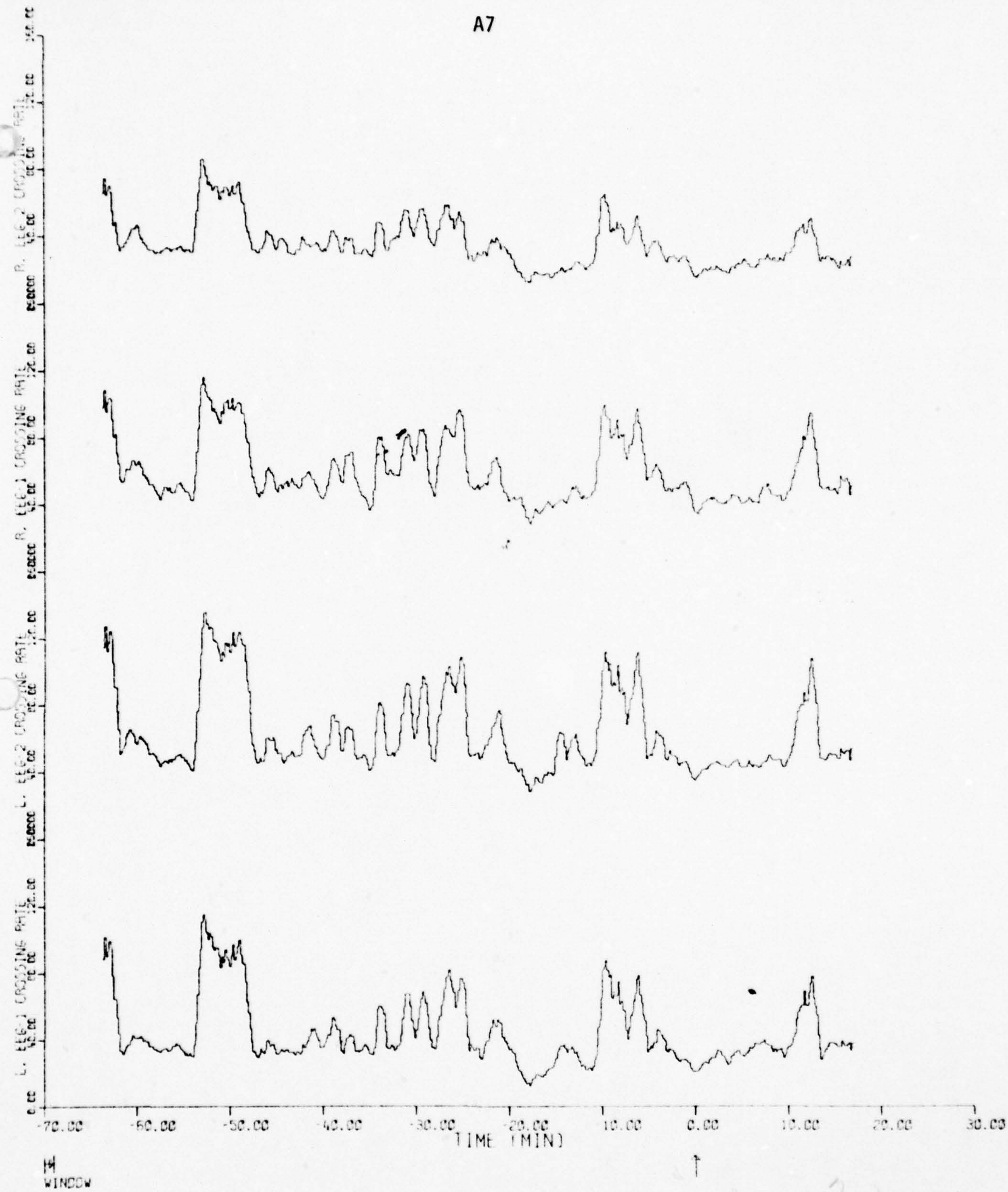
4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A0-3935 TAPE 1362 105GX

A6



BASELINE CROSSINGS VERSUS TIME

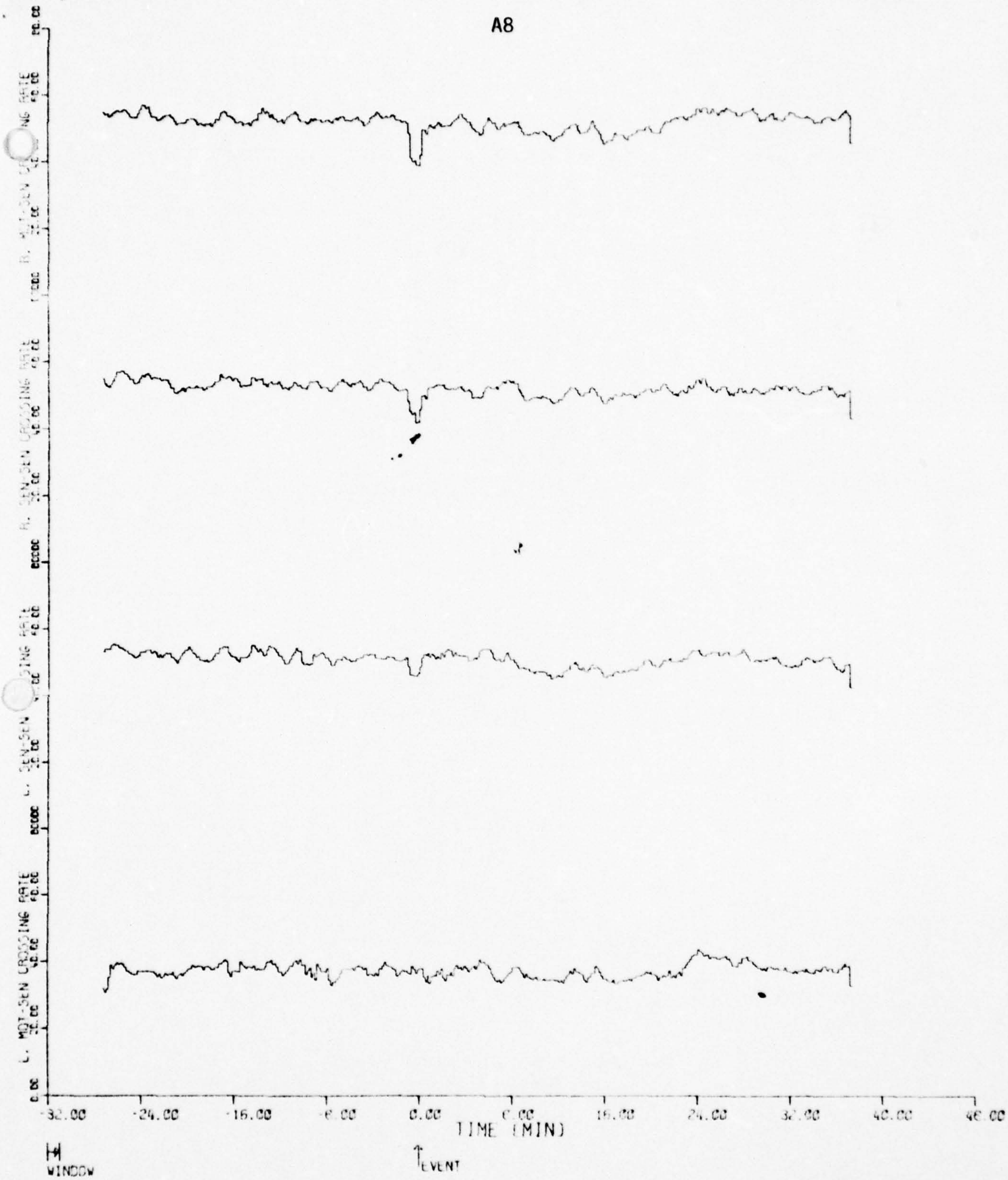
4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A0-3933 TAPE 1894 106GX



BASELINE CROSSINGS VERSUS TIME

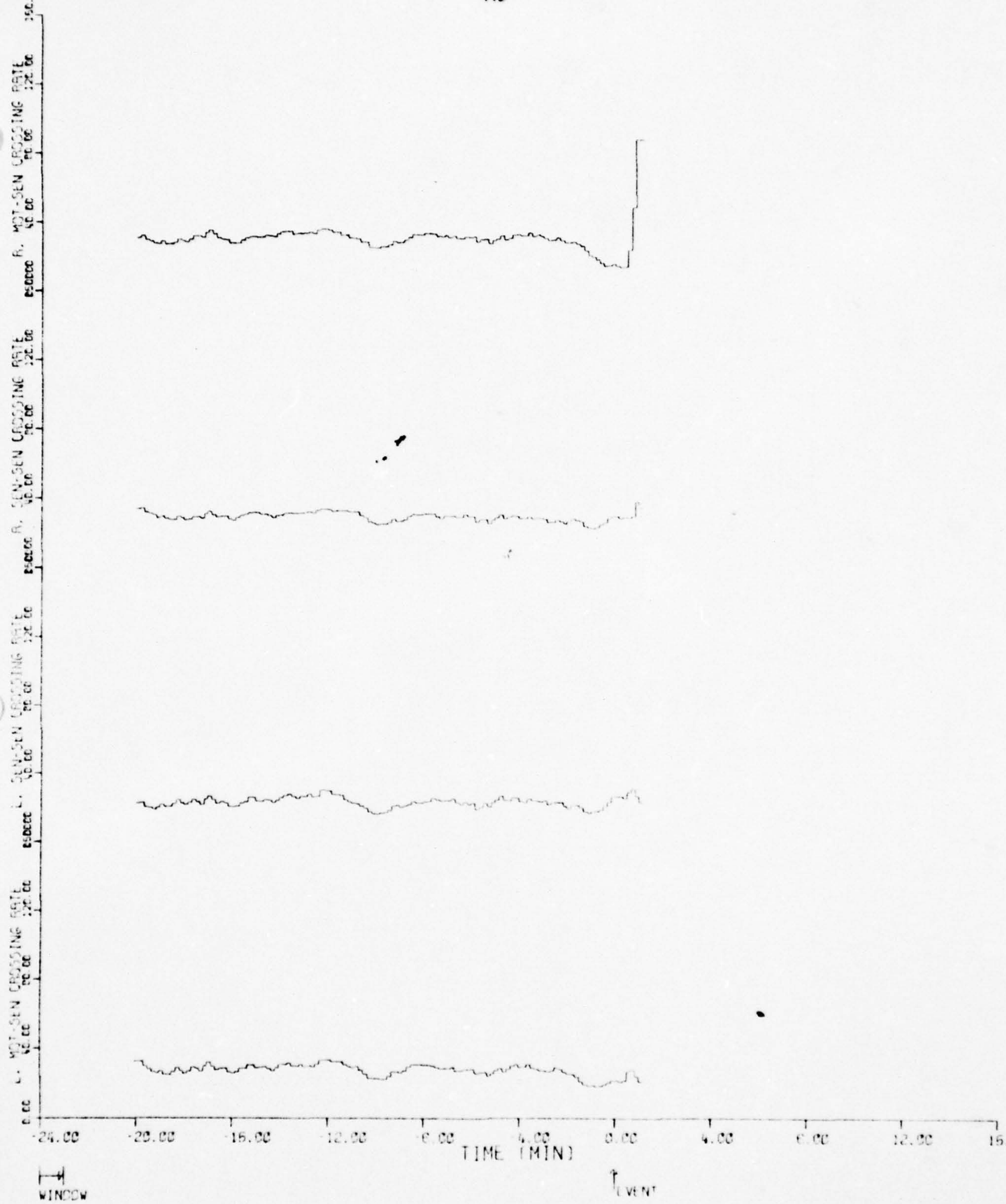
4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT AØ 3924 TAPE 1893 108GX

A8



BASELINE CROSSINGS VERSUS TIME

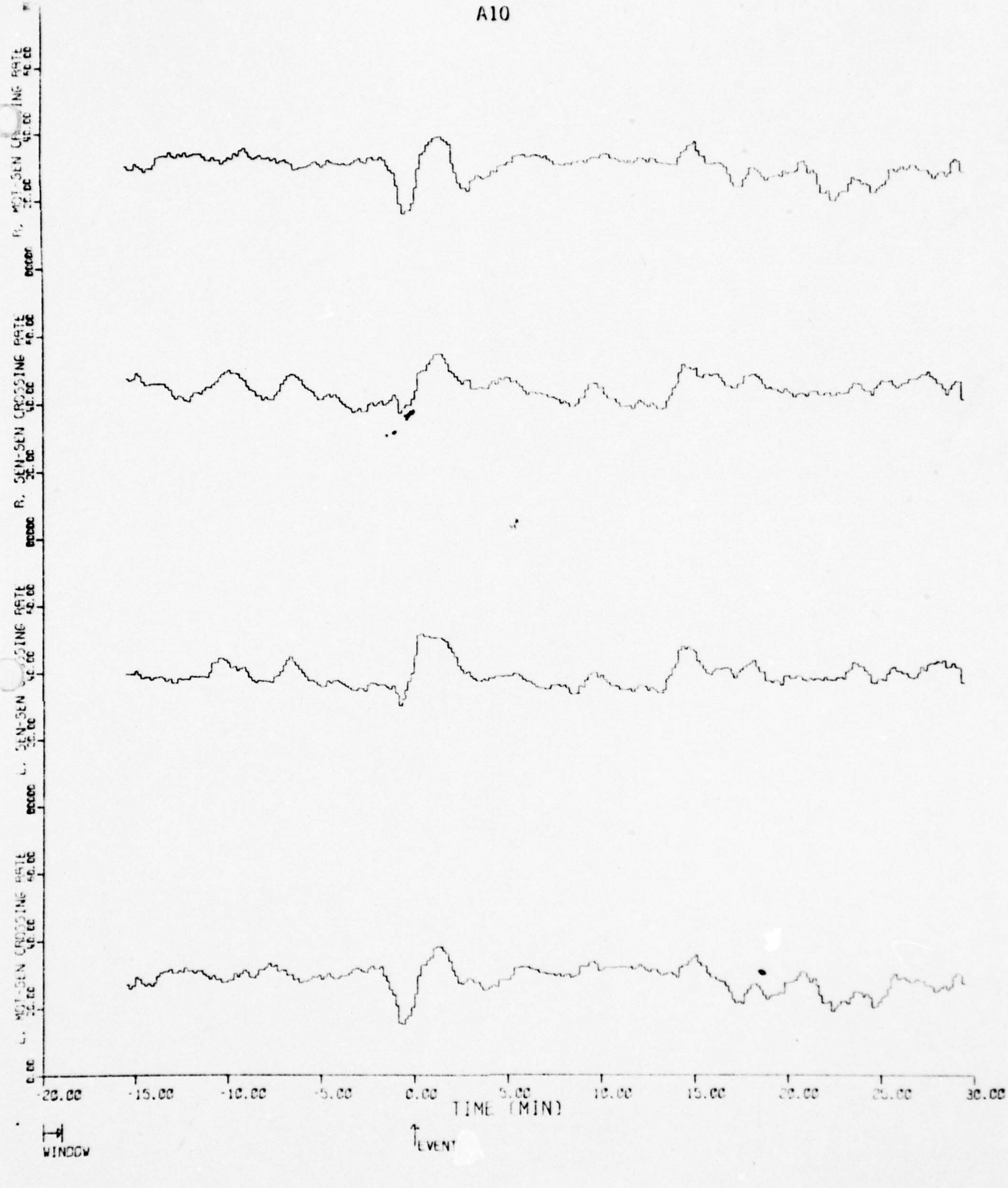
4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A0 4099 TAPE 1359 109.7GX



BASELINE CROSSINGS VERSUS TIME

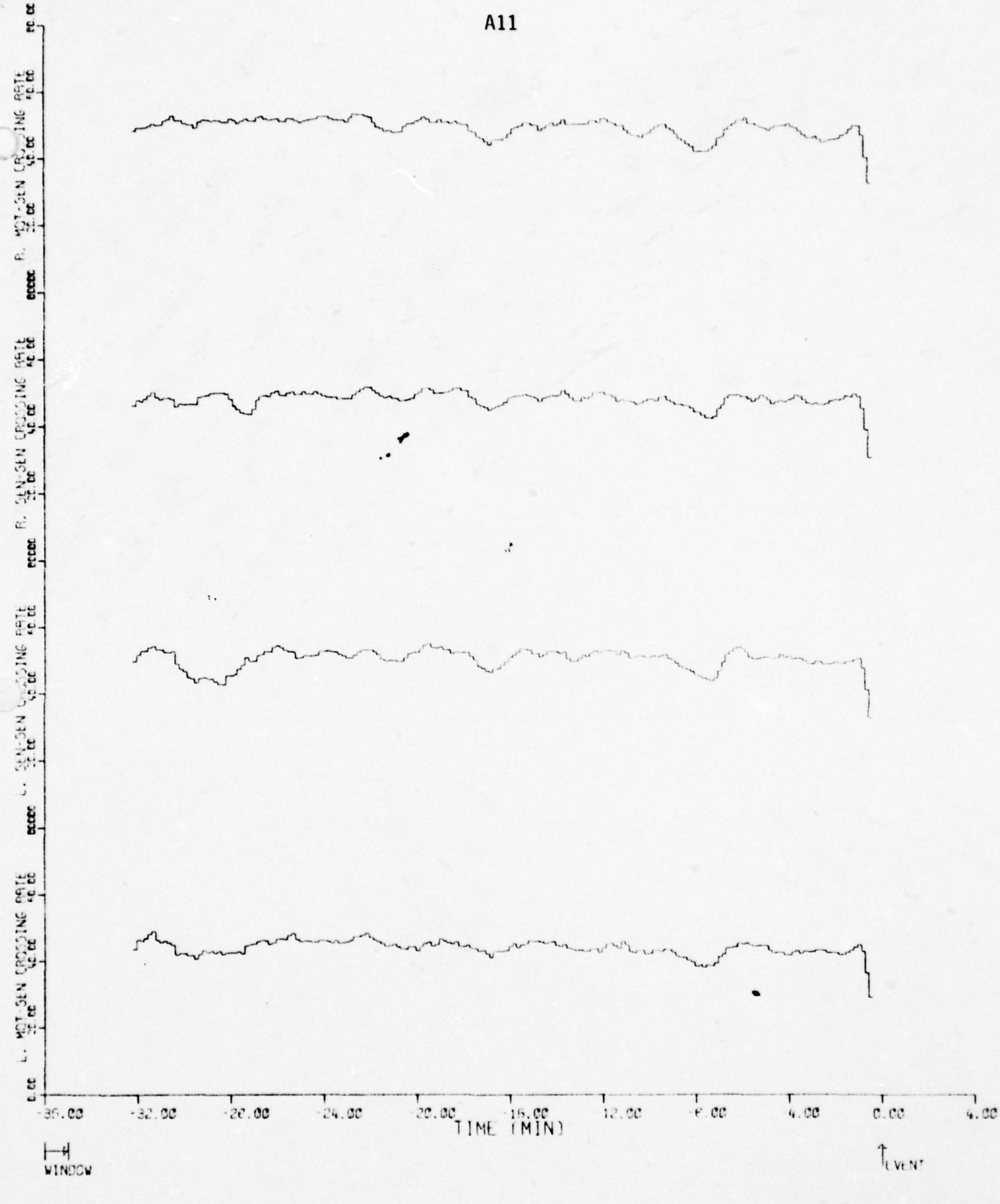
4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A0 3921 TAPE 1365 110GX

A10



BASELINE CROSSINGS VERSUS TIME

4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT A-3935 TAPE 1363 **127GX**



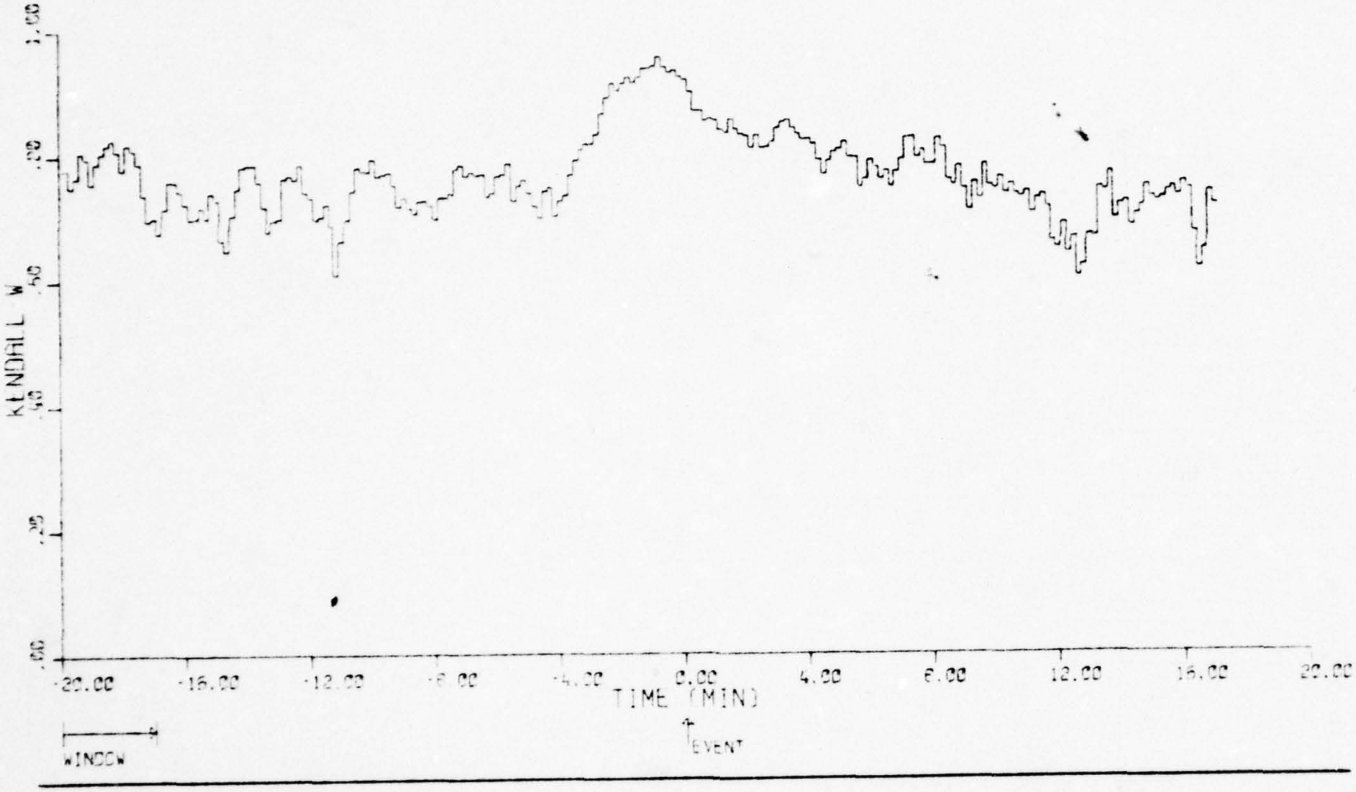
BASELINE CROSSINGS VERSUS TIME

4 CHANNELS
10. SEC EPOCHS 6 AVERAGED
SUBJECT AØ-4099 TAPE 1360 130GX

Figures B1 - B11

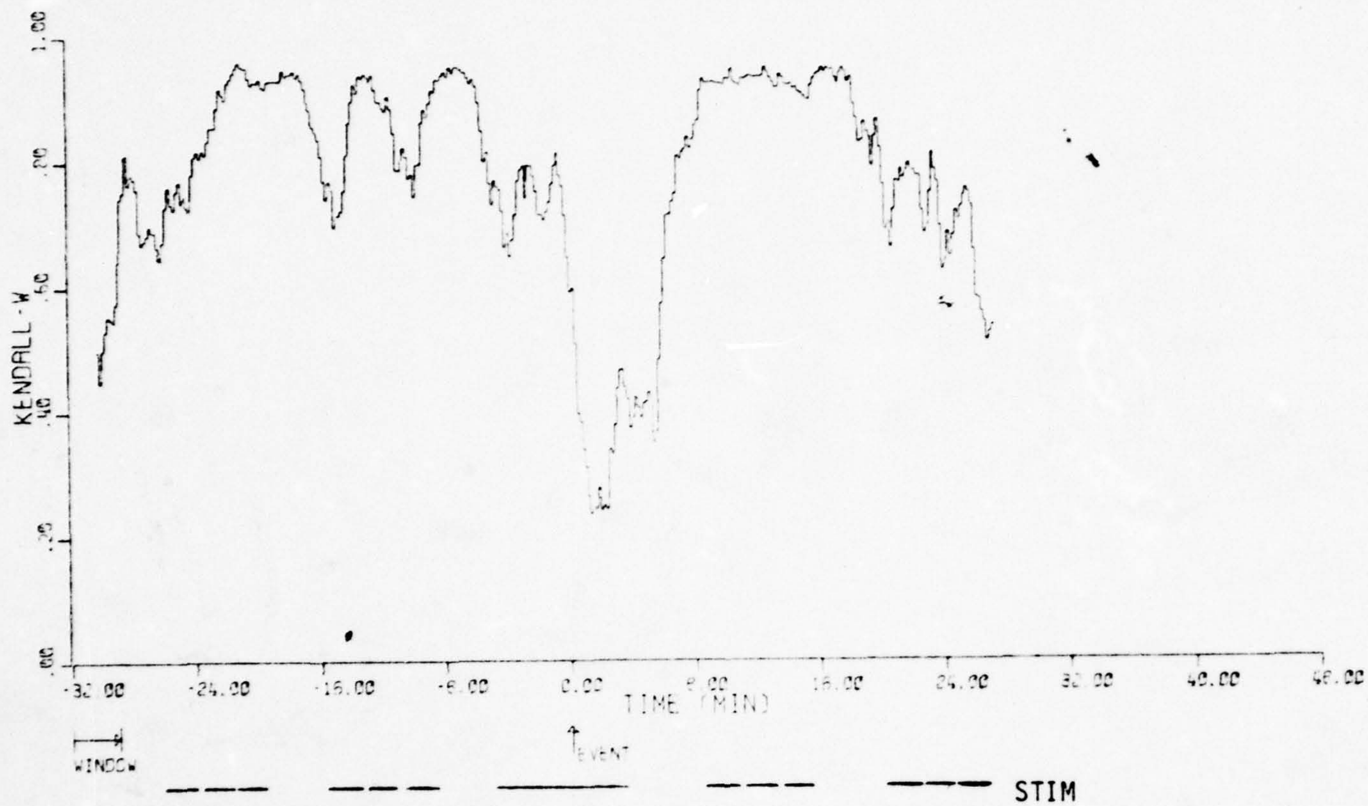
Concordance Analysis Summary Plots

B1



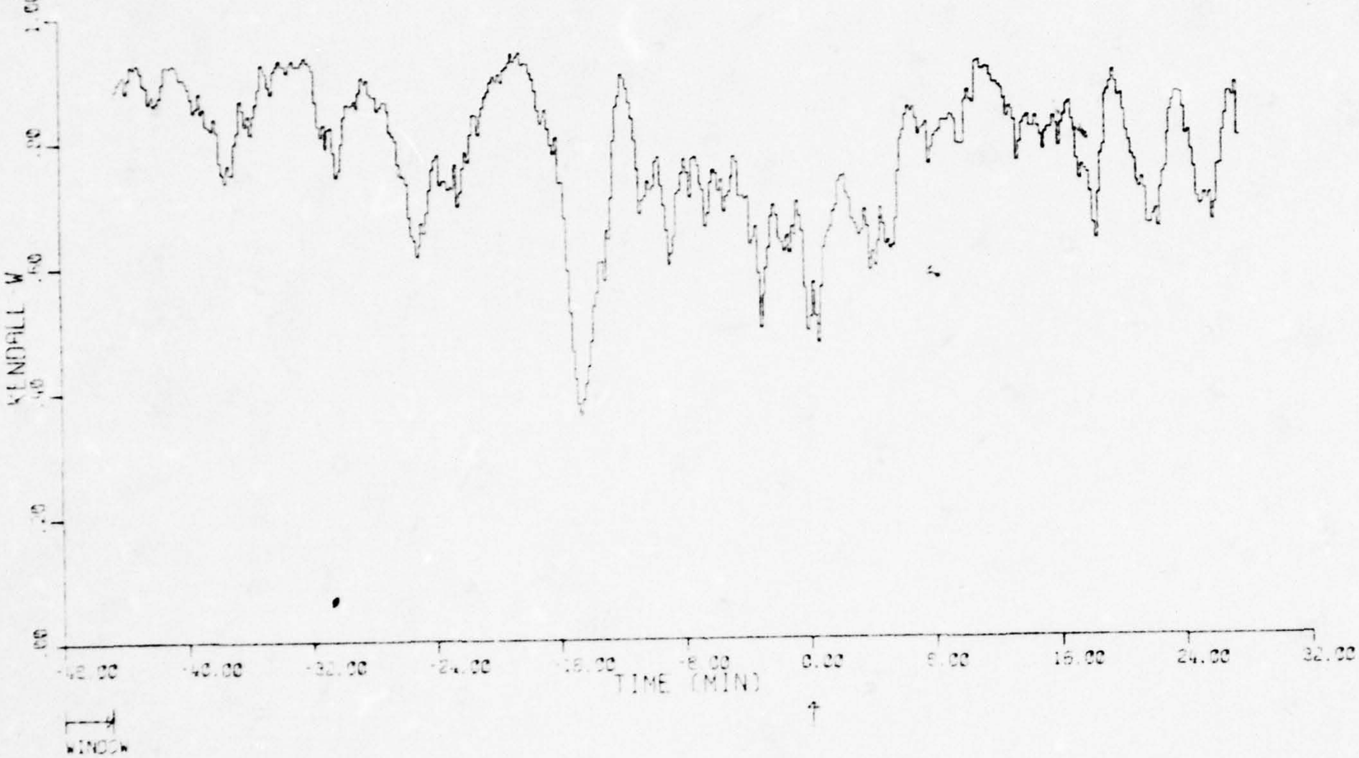
CONCORDANCE FROM ZERO CROSSINGS

4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E-04
SUBJECT AØ-3321 TAPE 1364 40GX



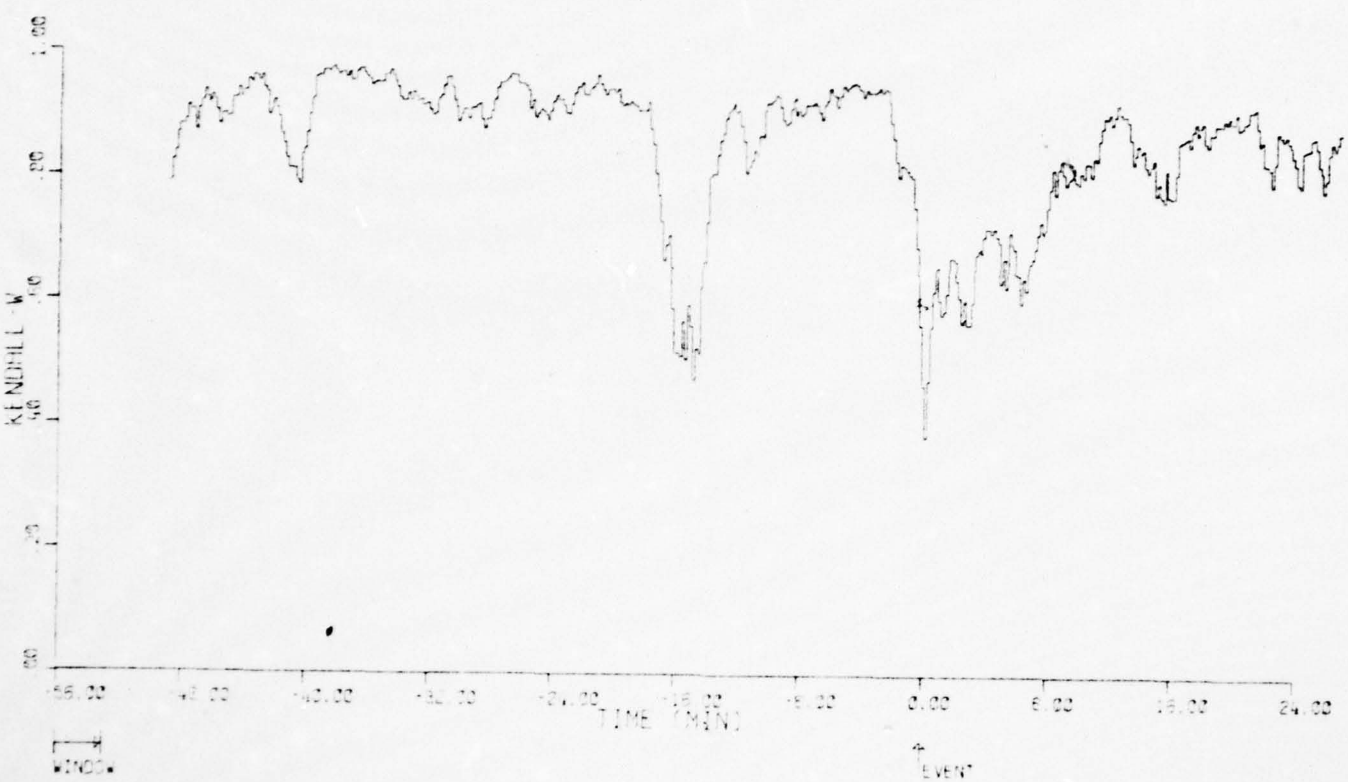
CONCORDANCE FROM ZERO CROSSINGS

4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E+04
SUBJECT AO 3146 TAPE 654 50GX



CONCORDANCE FROM ZERO CROSSINGS

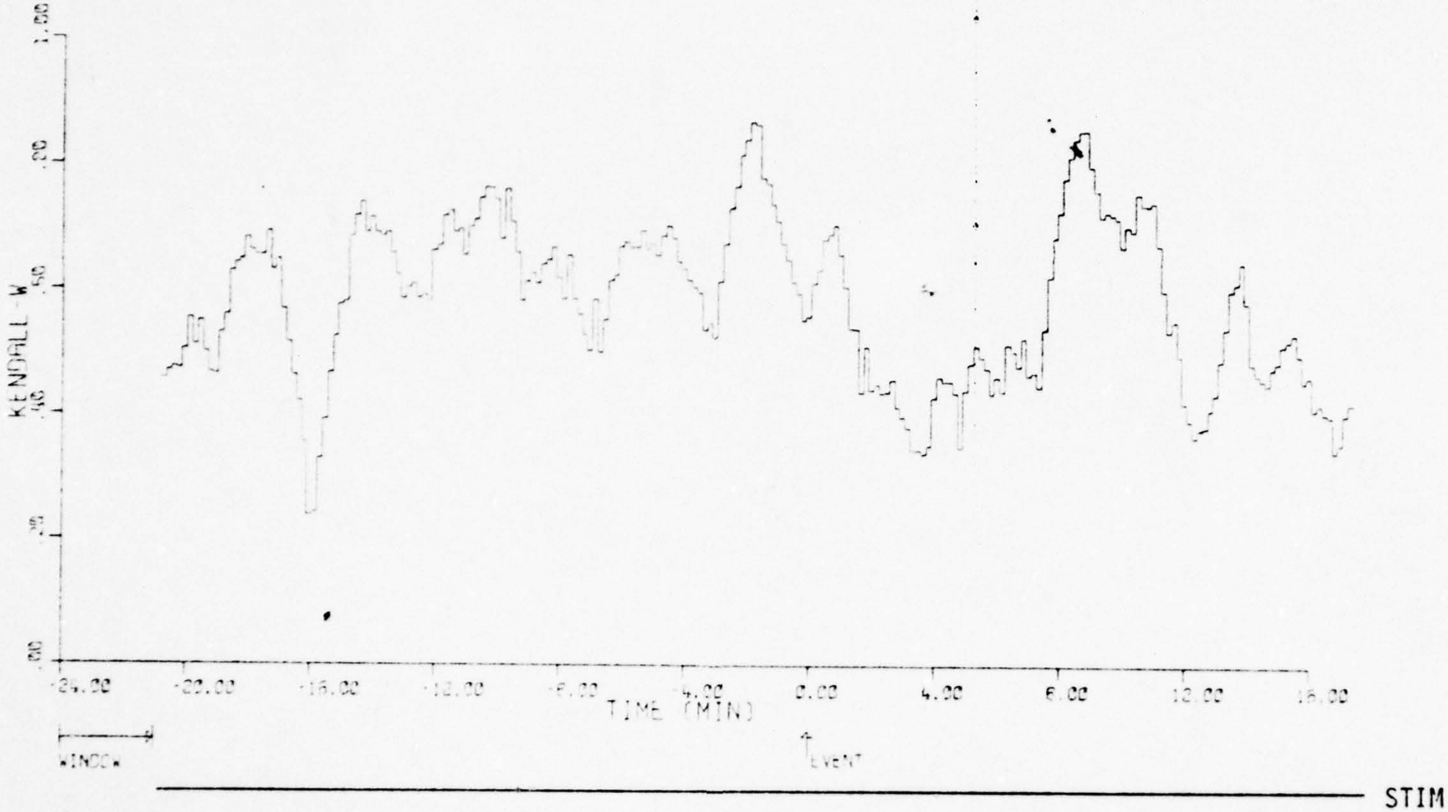
4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES Ø 7752E·Ø4
SUBJECT AØ 3943   TAPE 1691   80GX



CONCORDANCE FROM ZERO CROSSINGS

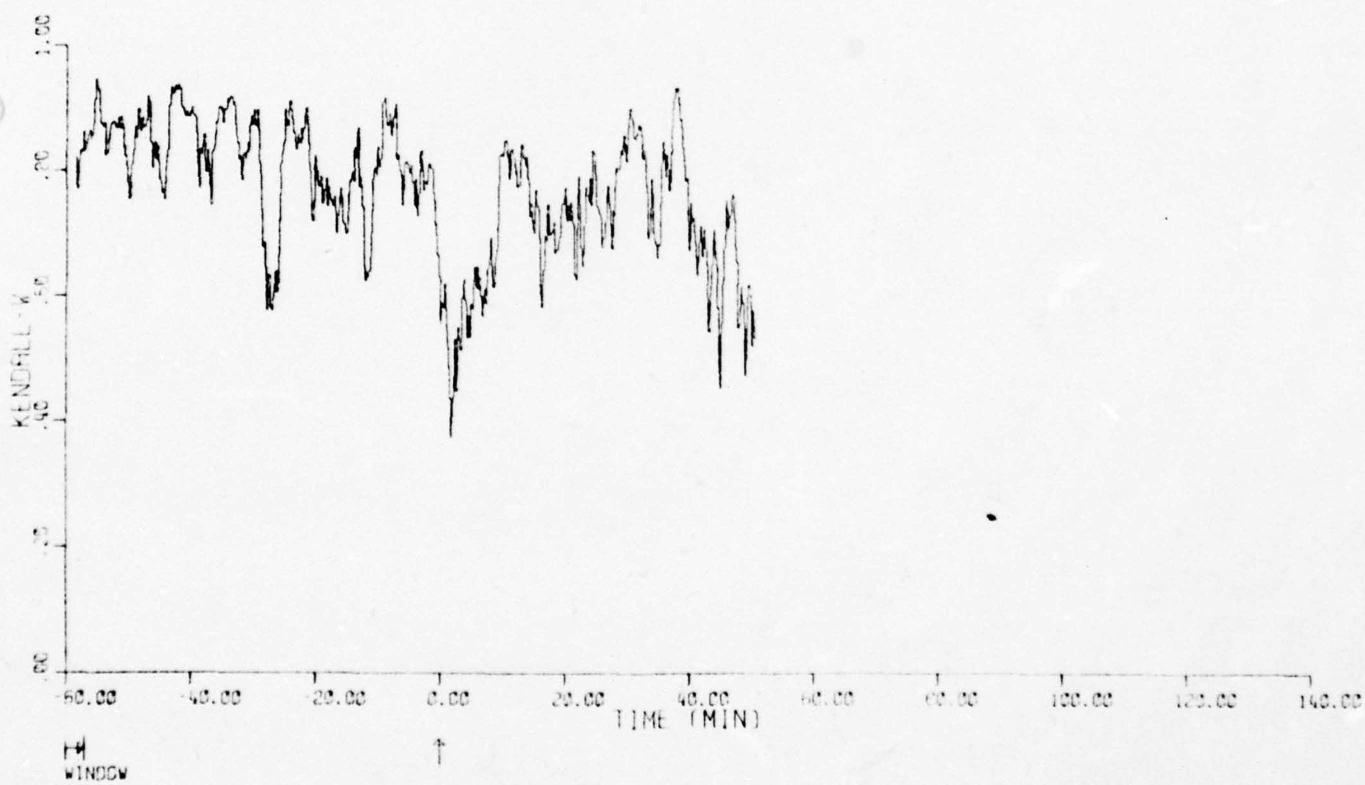
4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E·04
SUBJECT A0 3948 TAPE 1892 81GX

B5



CONCORDANCE FROM ZERO CROSSINGS

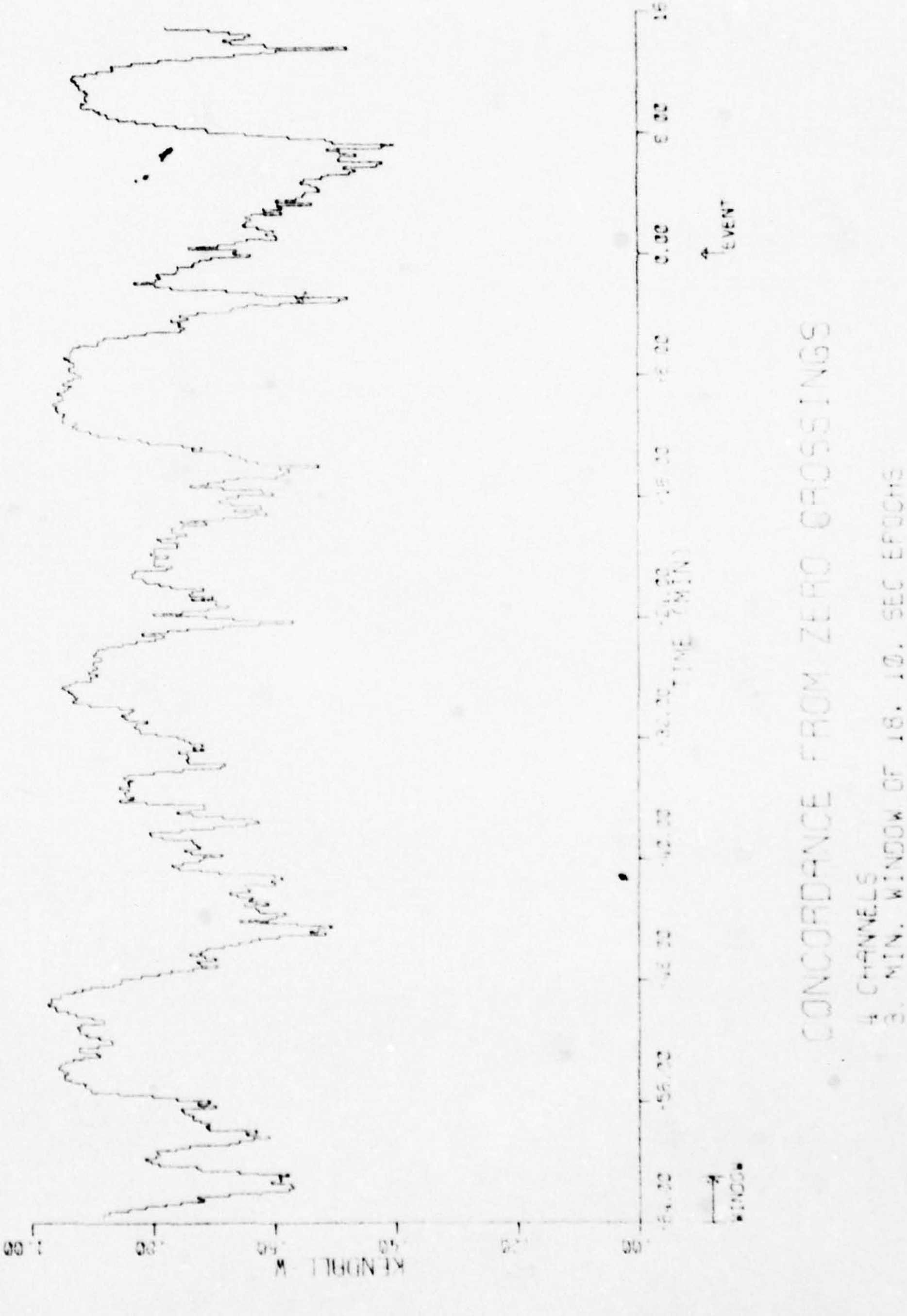
4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E·04
SUBJECT AO-3335 TAPE 1362 105GX



CONCORDANCE FROM ZERO CROSSINGS

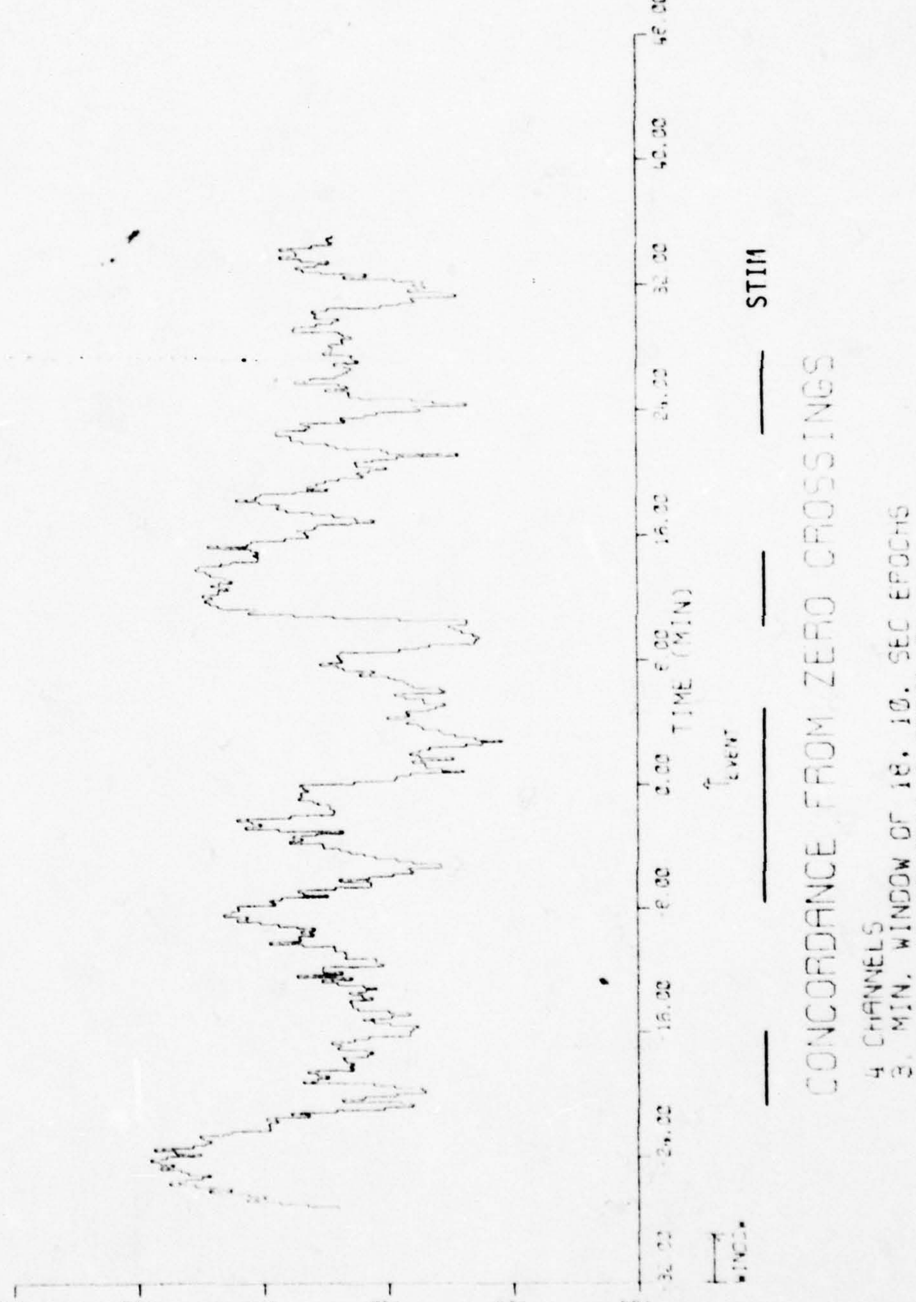
4 CHANNELS
3. MIN. WINDOW OF 18. 1Ø. SEC EPOCHS
MAX. SUM OF SQUARES Ø.7752E·Ø4
SUBJECT AØ-[illegible]933 TAPE 1694 106GX

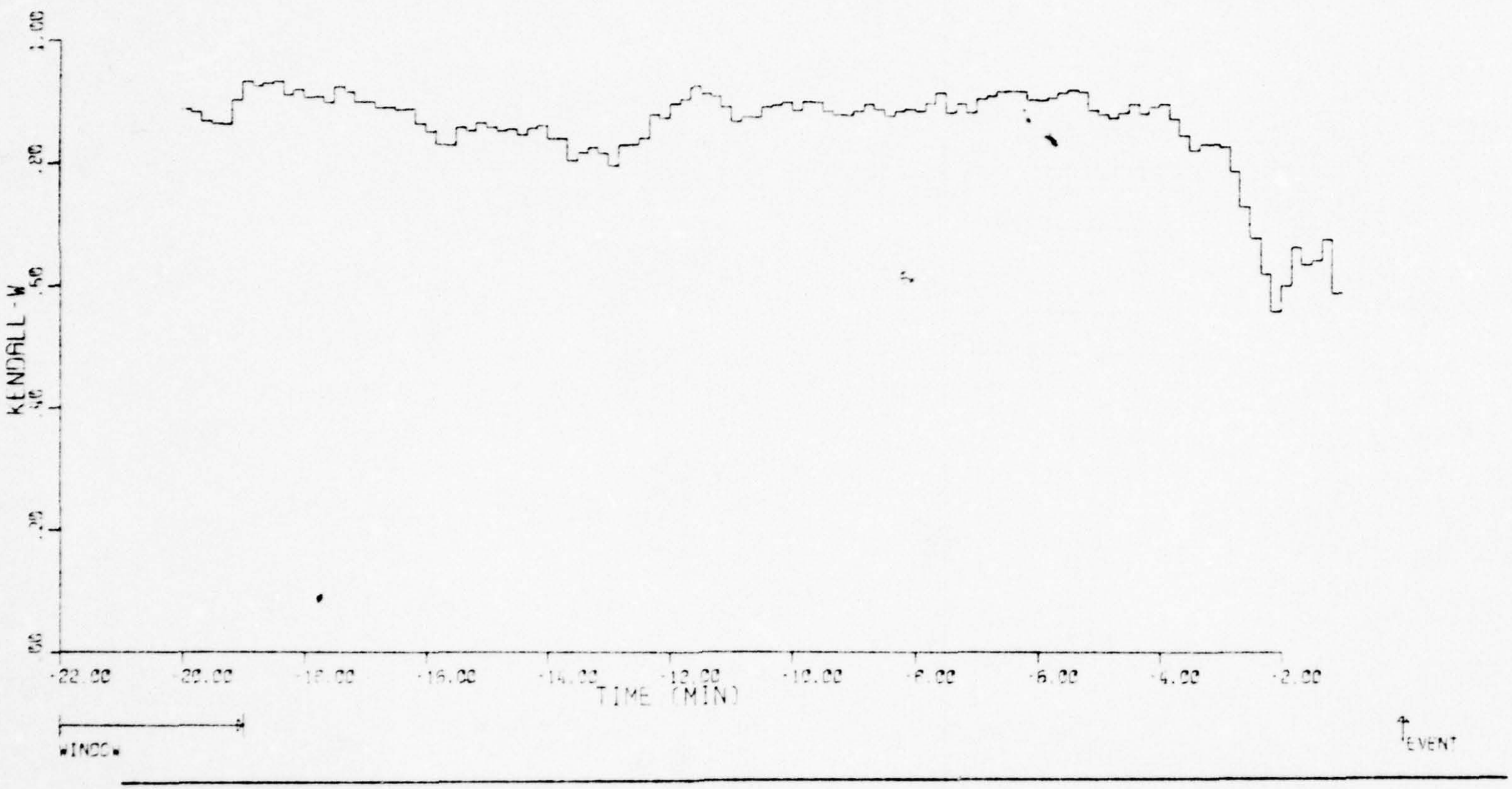
B7


KENDALL W
TIME (MIN)
EVENT
CONCORDANCE FROM ZERO CROSSINGS
4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES Ø.7752E·Ø4
SUBJECT AØ 3924 TAPE 1693

108GX

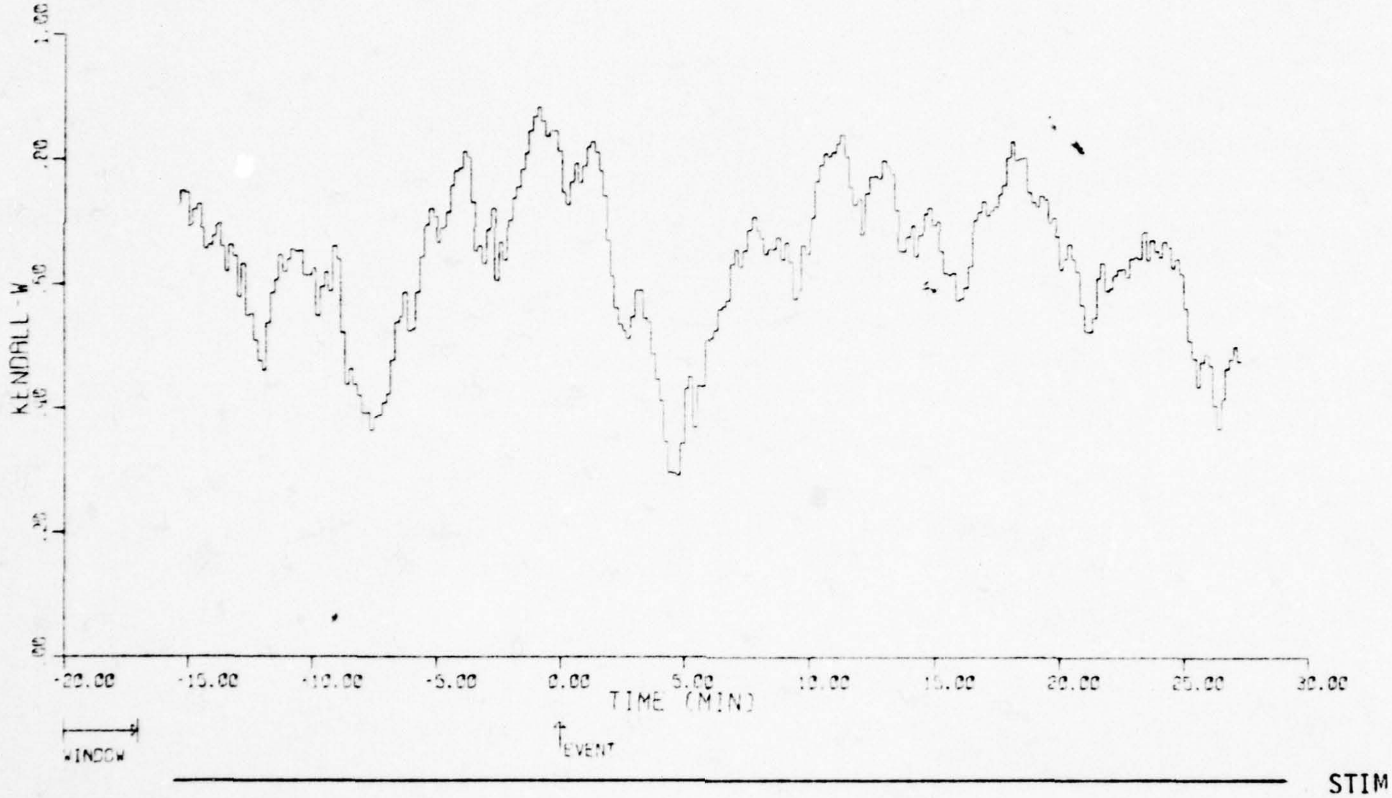
B8


CONCORDANCE FROM ZERO CROSSINGS
4 CHANNELS
3. MIN. WINDOW OF 10. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E-04
SUBJECT AO 4099 TAPE 1359
109.7GX
STIM
TIME (MIN)
EVENT
KENDALL-W



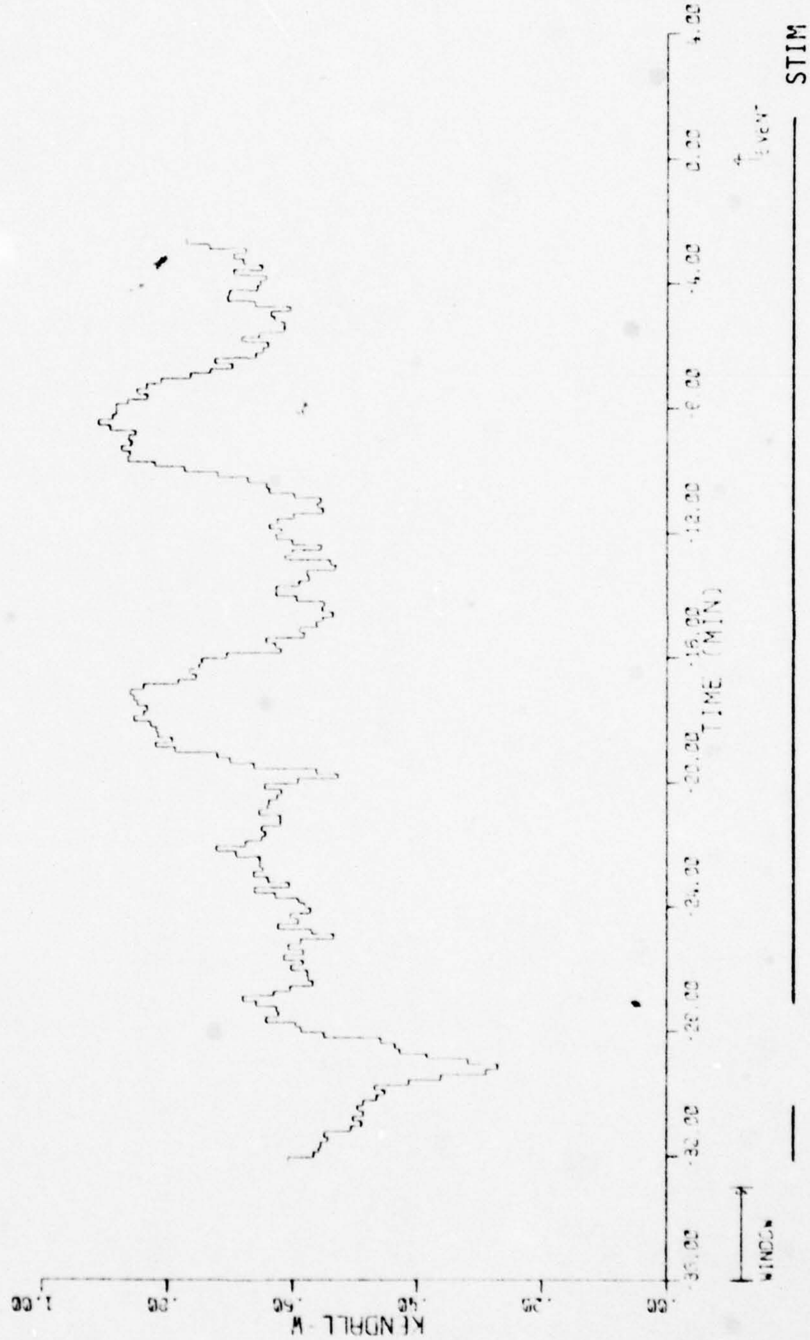
CONCORDANCE FROM ZERO CROSSINGS

4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E·04
SUBJECT A0 3921 TAPE 1365 110GX



CONCORDANCE FROM ZERO CROSSINGS

4 CHANNELS
3. MIN. WINDOW OF 18. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E-04
SUBJECT A-3935 TAPE 1363 127GX

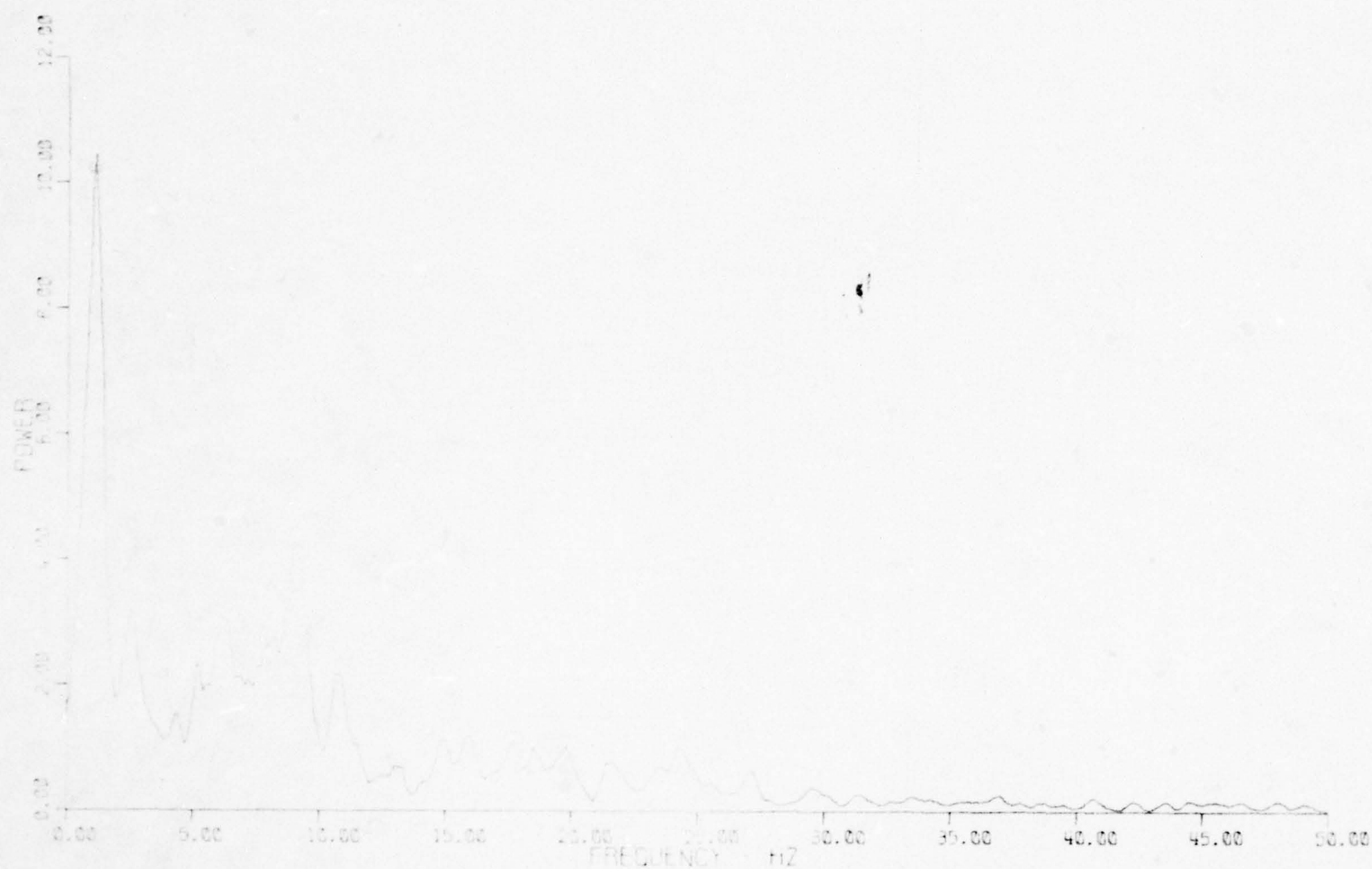


CONCORDANCE FROM ZERO CROSSINGS

4 CHANNELS
3. MIN. WINDOW OF 10. 10. SEC EPOCHS
MAX. SUM OF SQUARES 0.7752E·04
SUBJECT A0·4099 TAPE 1360 130GX

Figures C1 - C36

Power Spectral Density Plots



POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (10 minutes)

MAY 12,1978 TIME 10 9 31

R.MOT-SEN

A0 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (10 minutes)

MAY 12.1978 TIME 10 9 31

R.SEN-SEN ,
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (10 minutes)

MAY 12,1978 TIME 10 9 31

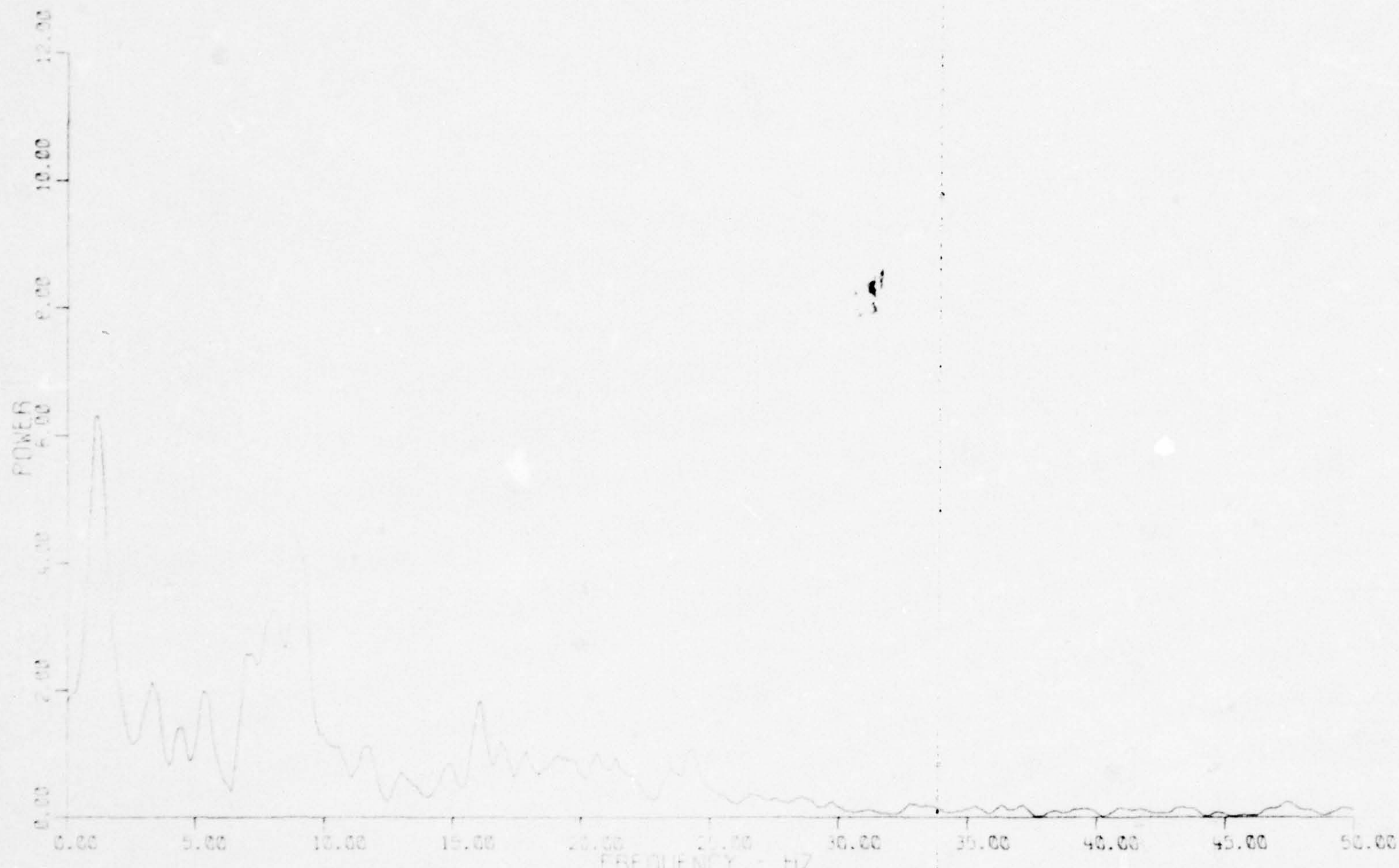
L.SEN-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

C4



POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (10 minutes)

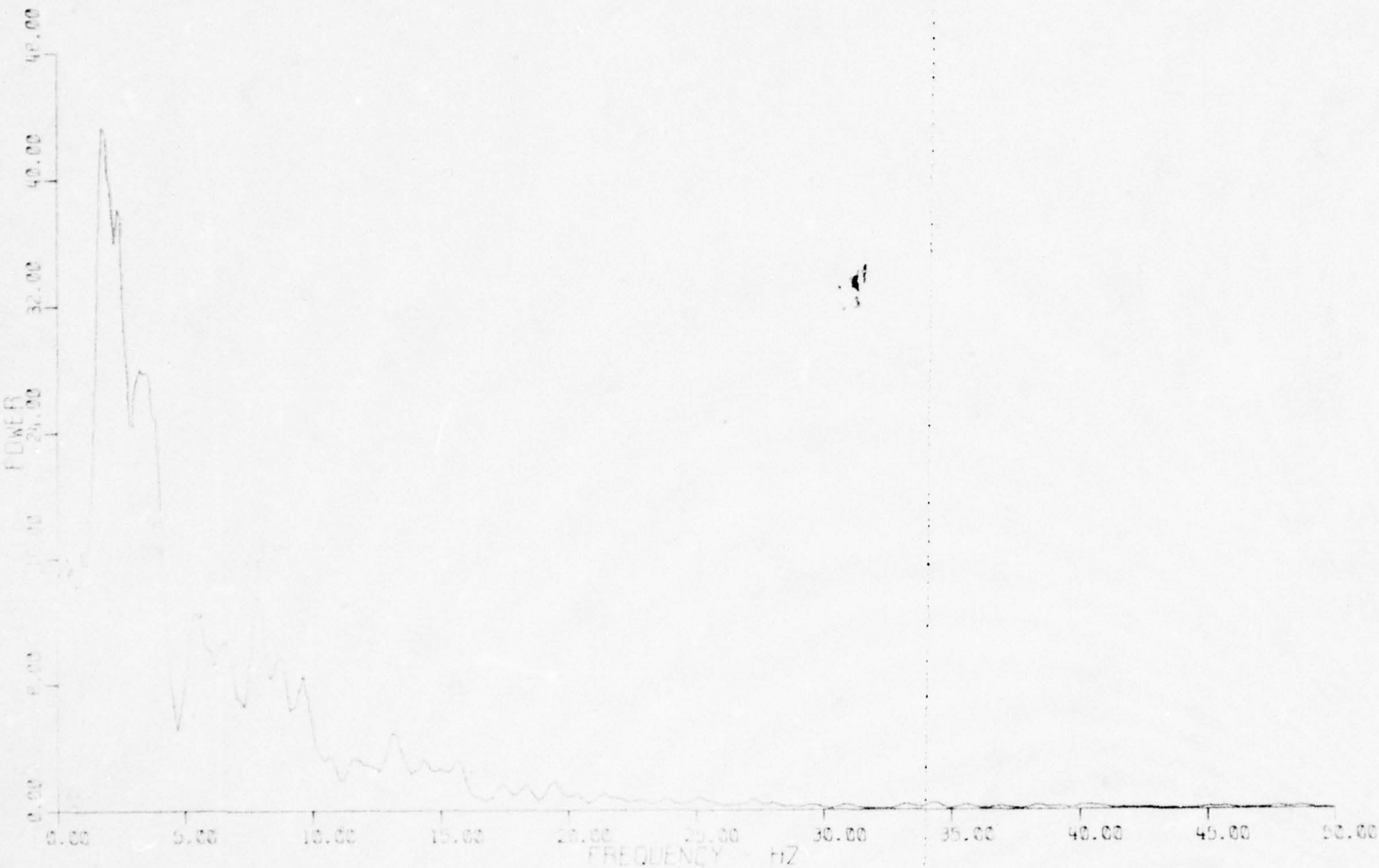
MAY 12.1978 TIME 10 9 31

L.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (5 minutes)

MAY 12.1978 TIME 10 14 31

R.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (5 minutes)

MAY 12,1978 TIME 10 14 31

R.SEN-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (5 minutes)

MAY 12.1978 TIME 10 14 31

L.SEN-SEN
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (5 minutes)

MAY 12.1978 TIME 10 14 31

L.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (30 seconds)

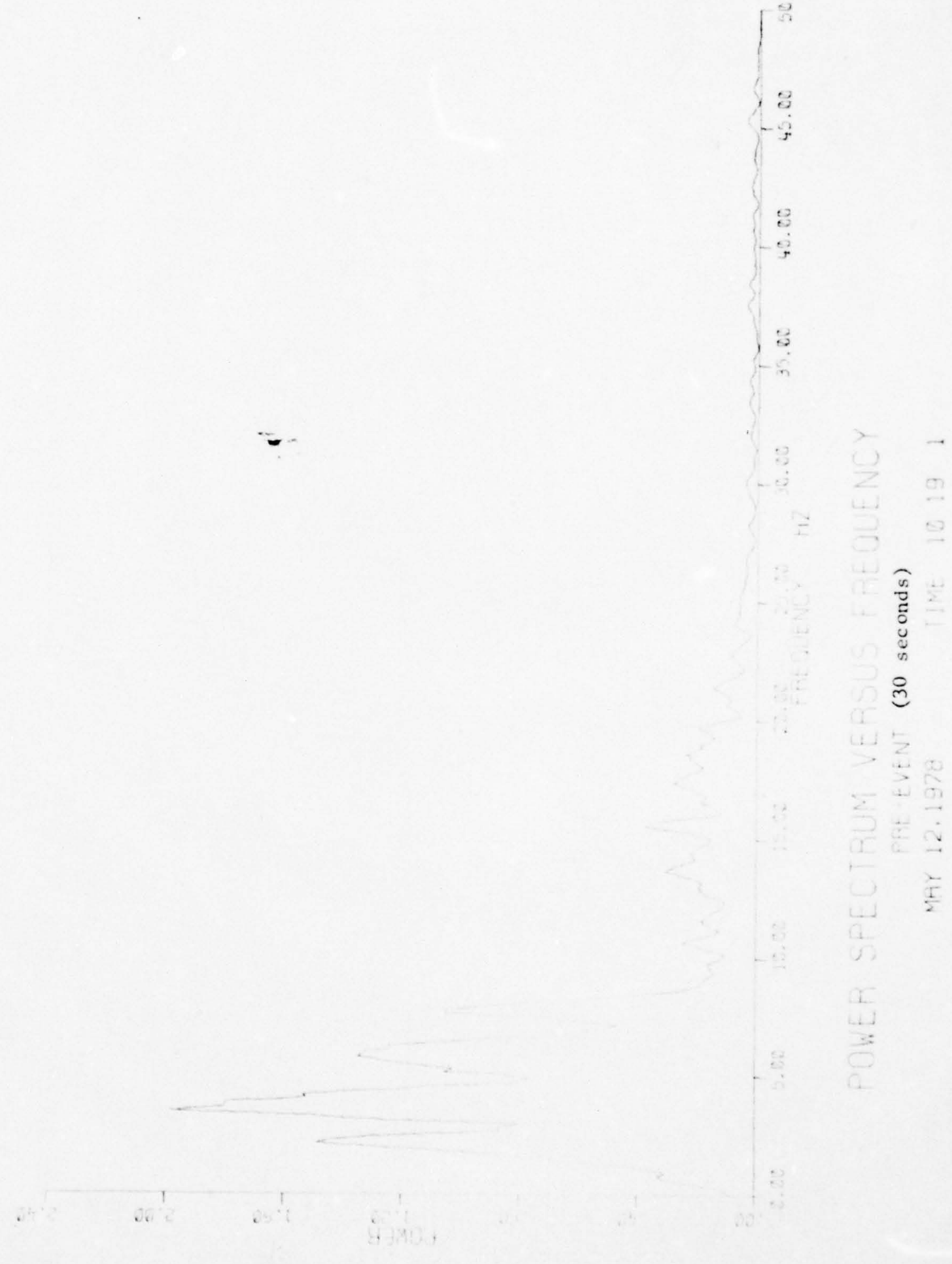
MAY 12.1978 TIME 10 19 1

R.MOT-SEN

SØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.


POWER SPECTRUM VERSUS FREQUENCY
PRE EVENT (30 seconds)
MAY 12.1978 TIME 10 19 1
R.SEN-SEN
SØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.
FREQUENCY HZ
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
POWER
.00
1.20
1.60
2.00
2.40

C11

POWER SPECTRUM VERSUS FREQUENCY
PRE-EVENT (30 seconds)
MAY 12,1978 TIME 10 19 1
L.SEN-SEN
50 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.
FREQUENCY - HZ
POWER
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
2.00
4.00
6.00
8.00
10.00
12.00

POWER SPECTRUM VERSUS FREQUENCY

PRE-EVENT (30 seconds)

MAY 12.1978 TIME 10 19 1

L.MOT-SEN ,
SØ 3933

NYQUIST FREQUENCY	50.00 HZ.
FILTER BANDWIDTH	Ø.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT 1 minute

MAY 12, 1978 TIME 10 20 31

R.MOT-SEN /
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (1 minute)

MAY 12, 1978 TIME 10 20 31

R.SEN-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (1 minute)

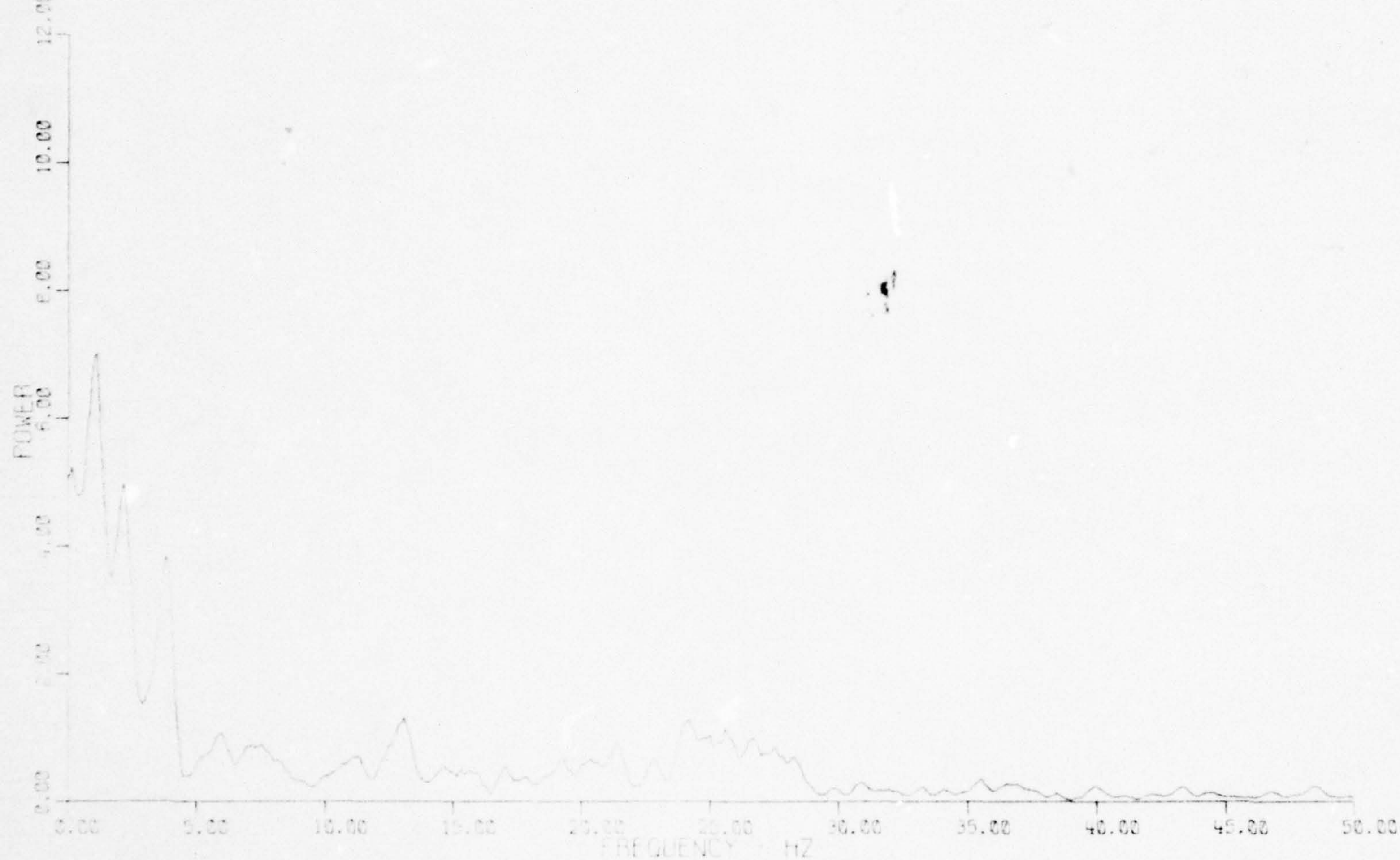
MAY 12. 1978 TIME 10 20 31

L.SEN-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (1 minute)

MAY 12, 1978 TIME 10 20 31

L.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (2 minutes)

MAY 12, 1978 TIME 10 21 31

R.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (2 minutes)

MAY 12. [illegible] TIME 10 21 31

R.SEN-SEN ,
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (2 minutes)

MAY 12, 1978 TIME 10 21 31

L.SEN-SEN
A0 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (2 minutes)

MAY 12, 1978 TIME 10 21 31

L.MOT-SEN /
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (5 minutes)

MAY 12, 1978 TIME 10 24 31

R.MOT-SEN

A0 3933

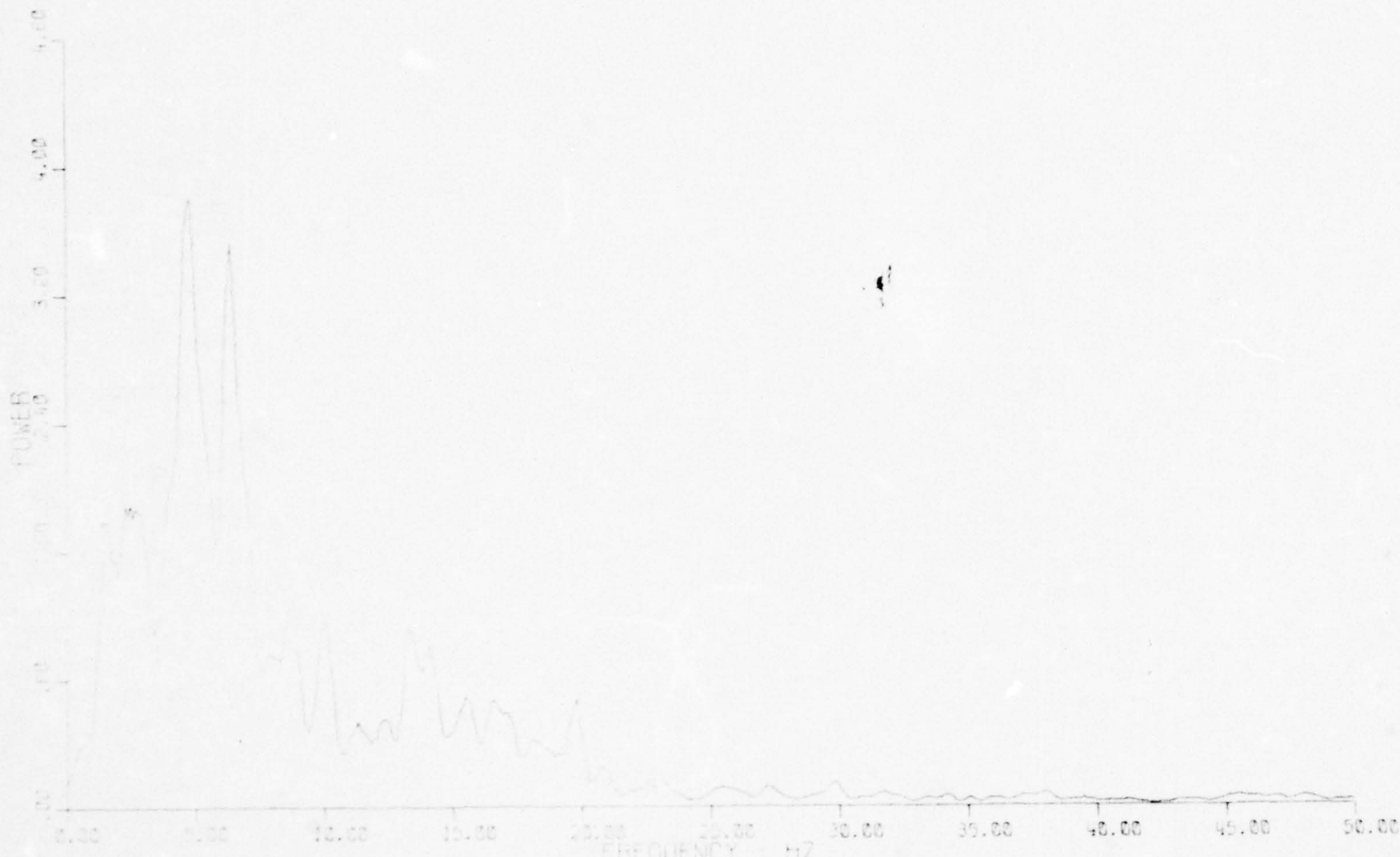
NYQUIST FREQUENCY 50.00 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (5 minutes)

MAY 12, 1978   TIME 10 24 31

R.SEN-SEN /
AØ 3933
NYQUIST FREQUENCY   50.00 HZ.
FILTER BANDWIDTH   0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (5 minutes)

MAY 12, 1978 TIME 10 24 31

L.SEN-SEN /
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

70

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (5 minutes)

MAY 12, 1978 TIME 10 24 31

L.MOT-SEN 1
A0 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (10 minutes)

MAY 12, 1978 TIME 10 29 31

R.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

C26

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (10 minutes)

MAY 12, 1978 TIME 10 29 31

R.SEN-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (10 minutes)

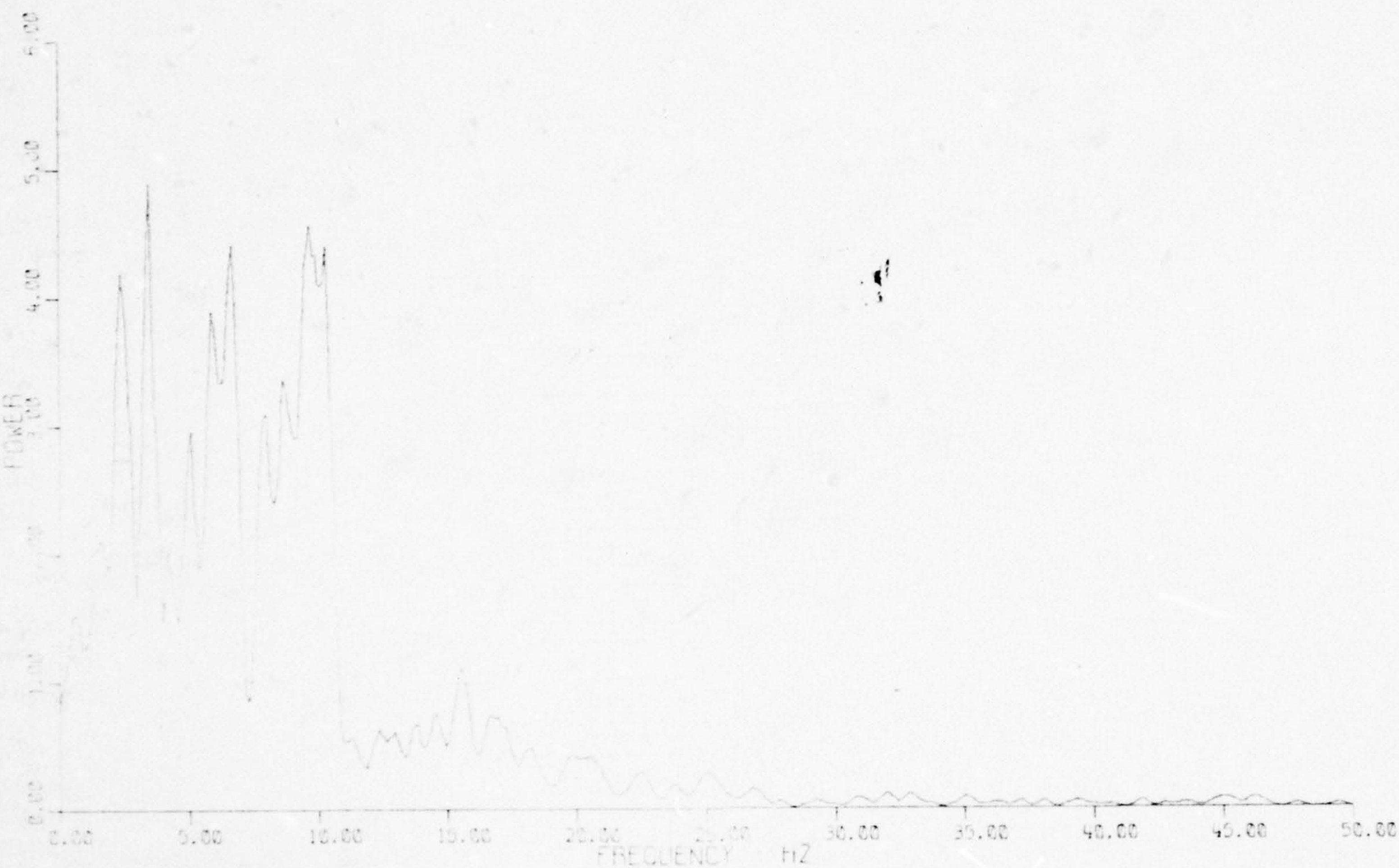
MAY 12, 1978 TIME 10 29 31

L.SEN-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (10 minutes)

MAY 12, 1978 TIME 10 29 31

L.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

EVENT (20 minutes)

MAY 12, 1978 TIME 10 39 31

R.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

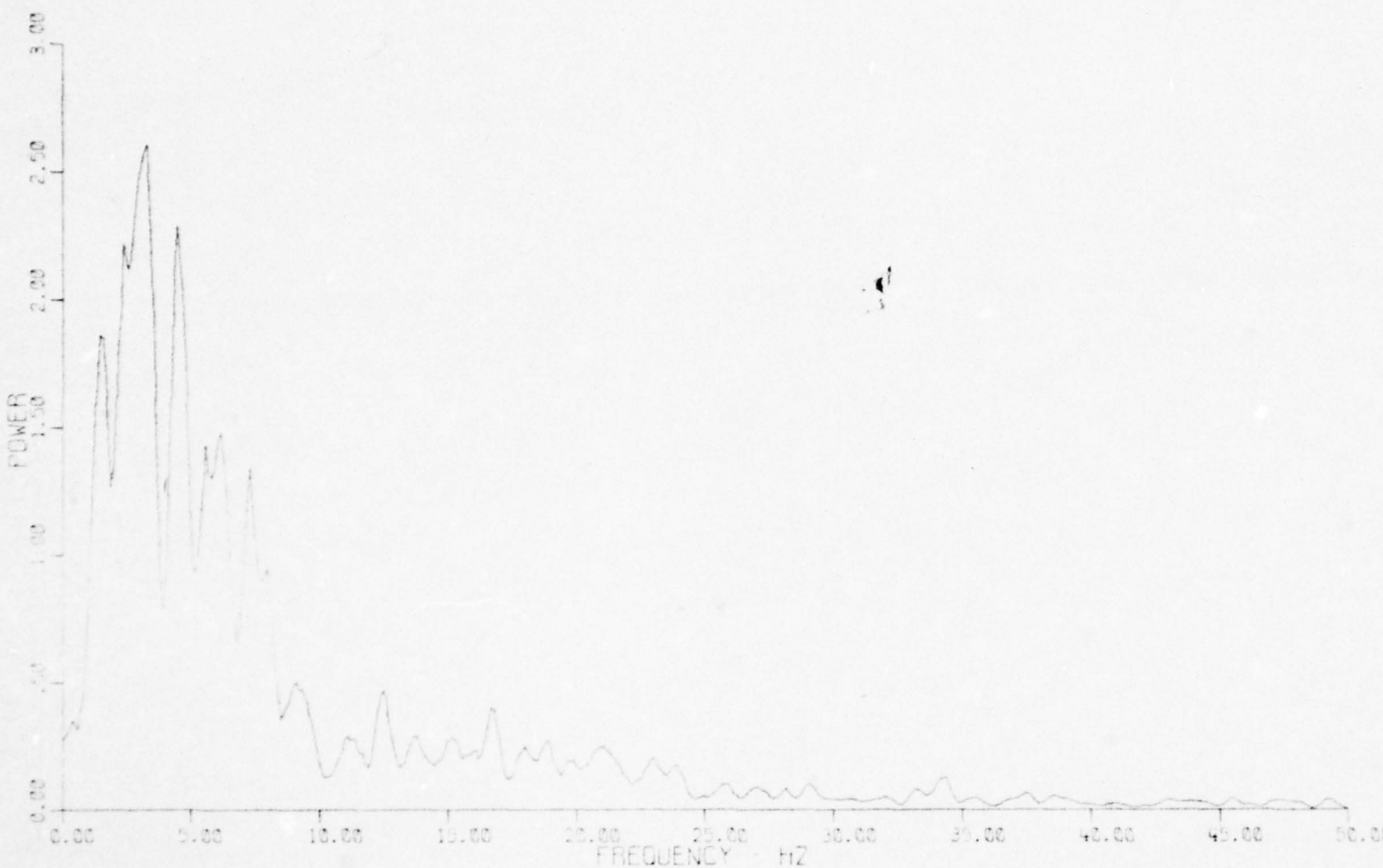
FILTER BANDWIDTH 0.50 HZ.

POWER SPECTRUM VERSUS FREQUENCY

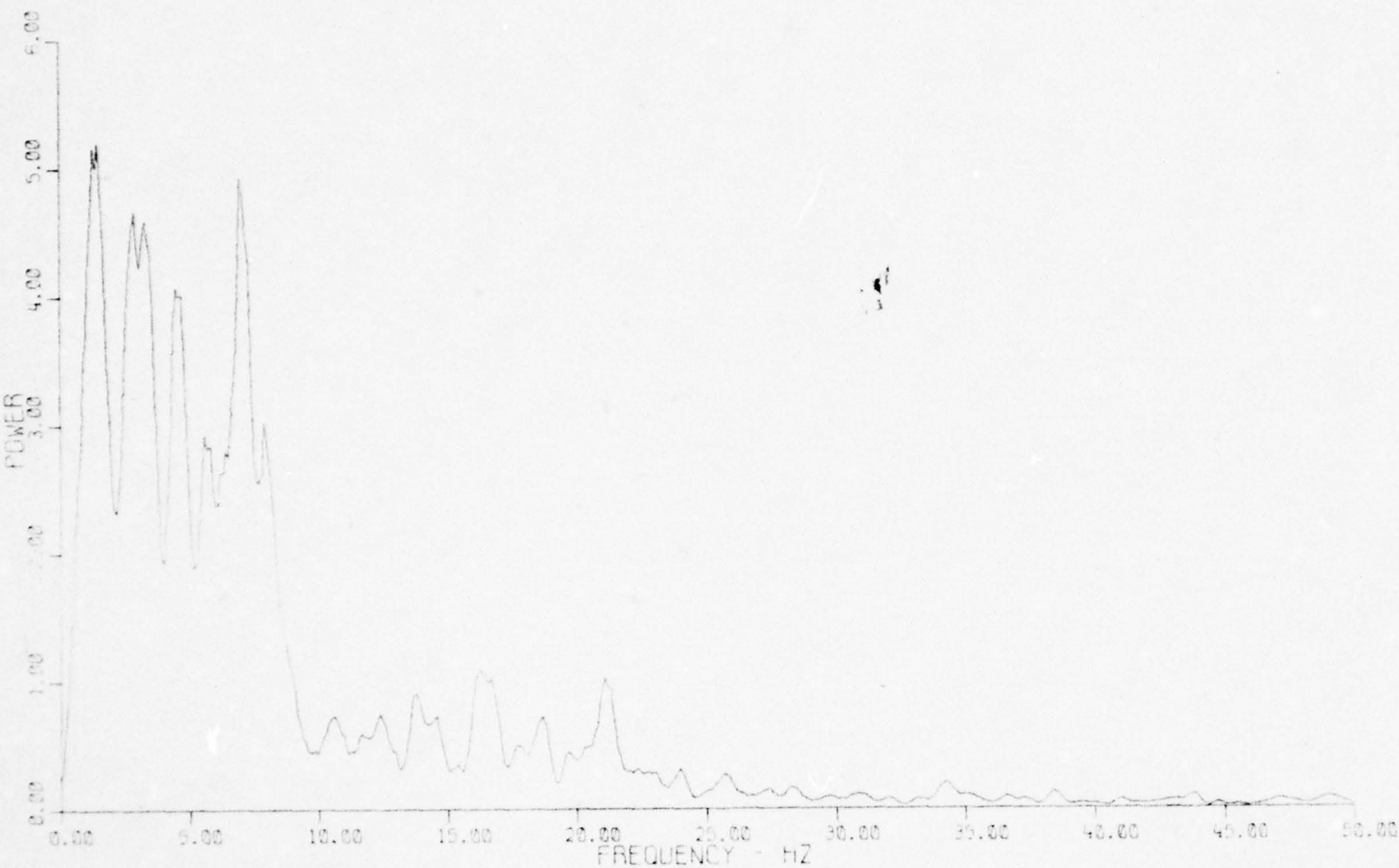
POST-EVENT (20 minutes)

MAY 12. 1976 TIME 10 39 31

R.SEN-SEN ,
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY
POST-EVENT (20 minutes)
MAY 12, 1978 TIME 10 39 31
L.SEN-SEN
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (20 minutes)

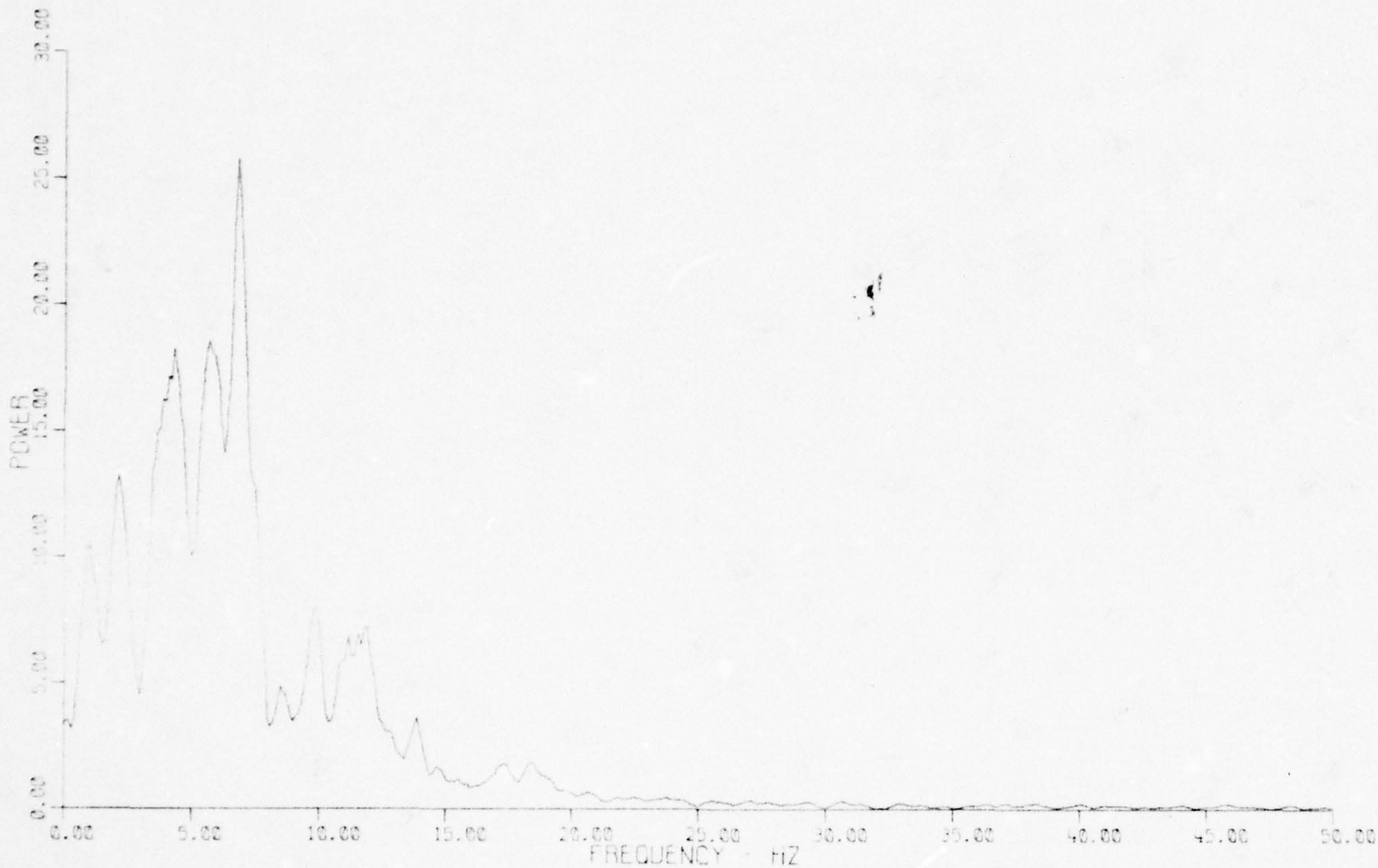
MAY 12, 1978 TIME 10 39 31

L.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.



POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (30 minutes)

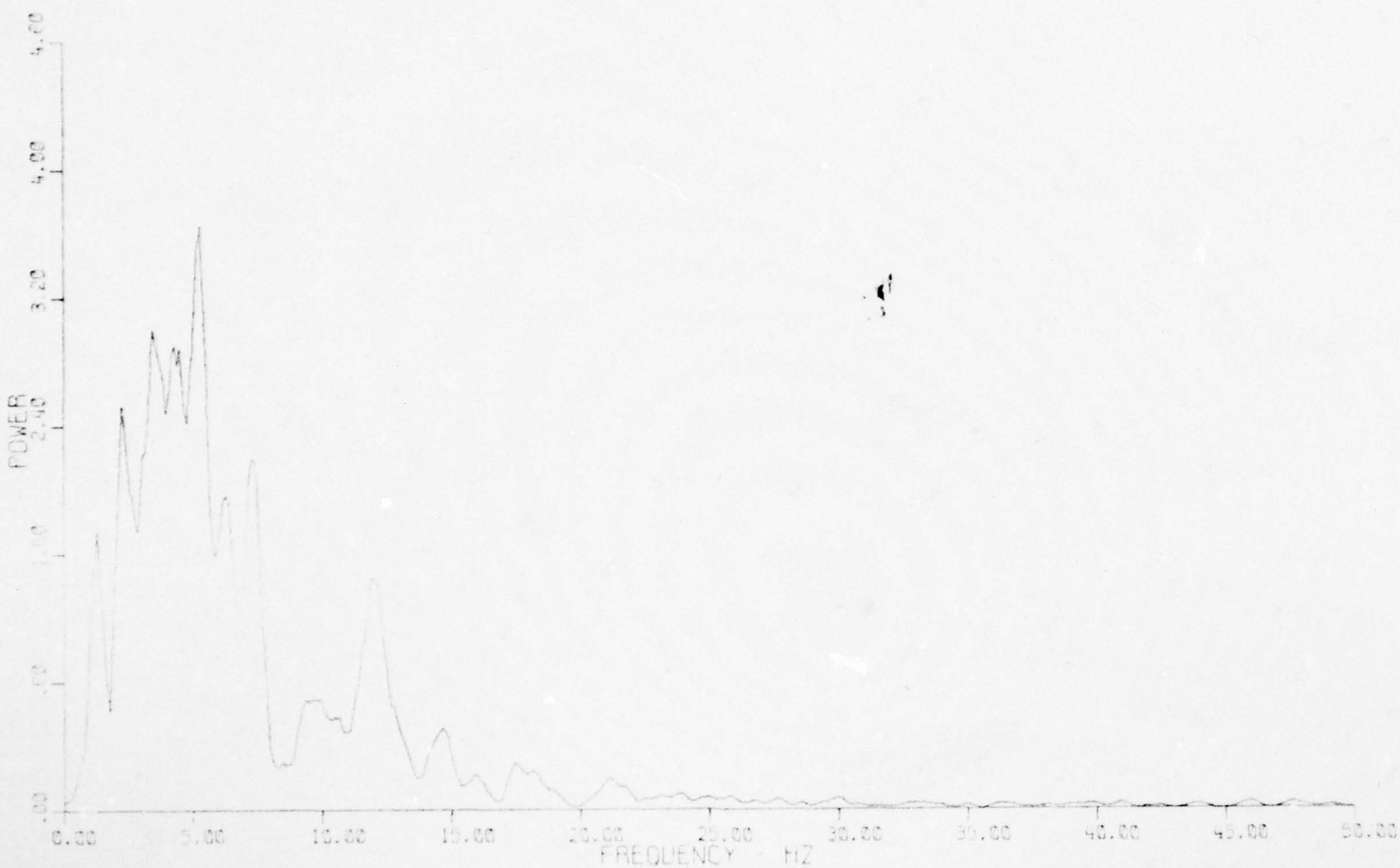
MAY 12, 1978 TIME 10 49 31

R.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

FILTER BANDWIDTH 0.50 HZ.



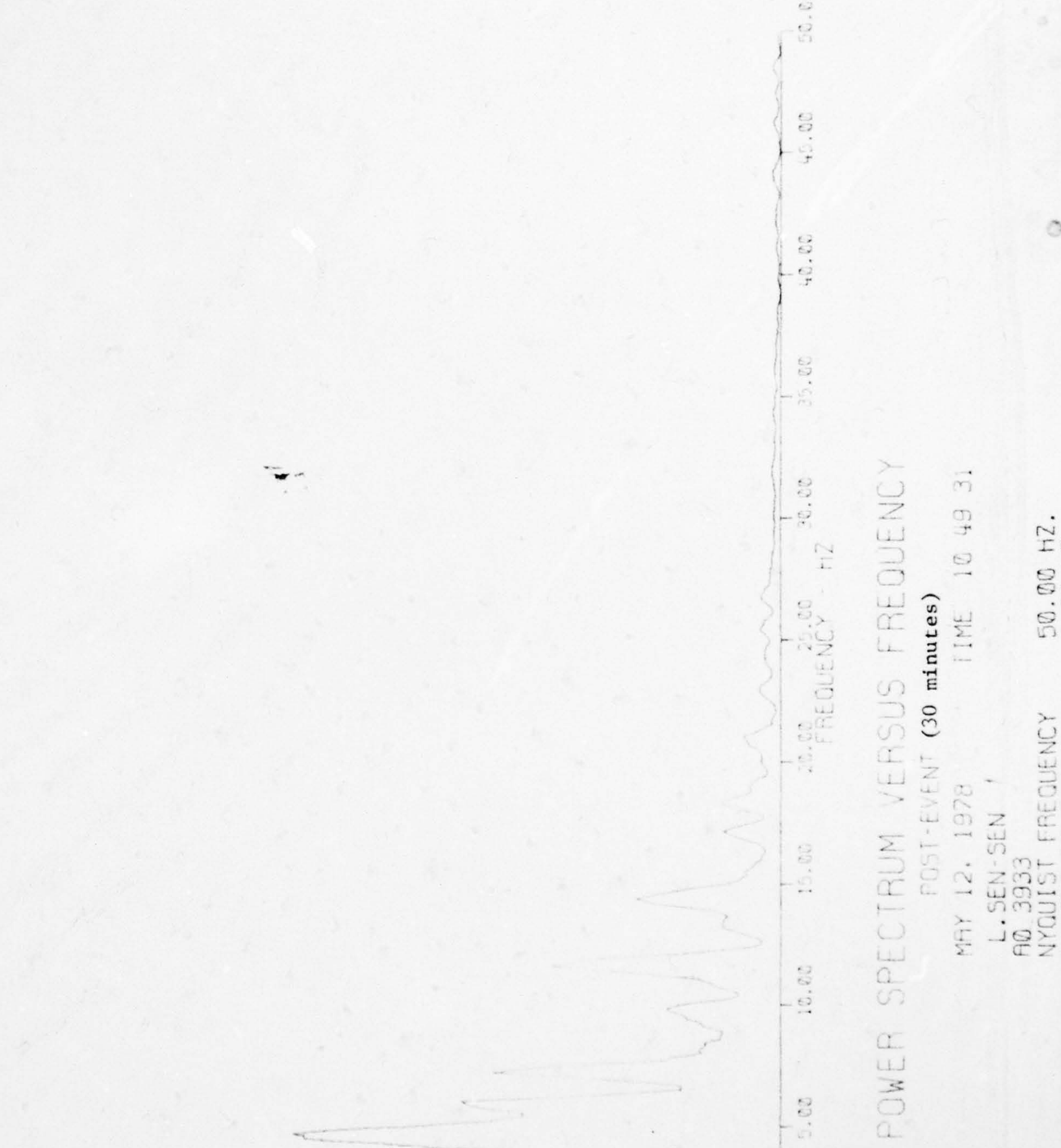
POWER SPECTRUM VERSUS FREQUENCY

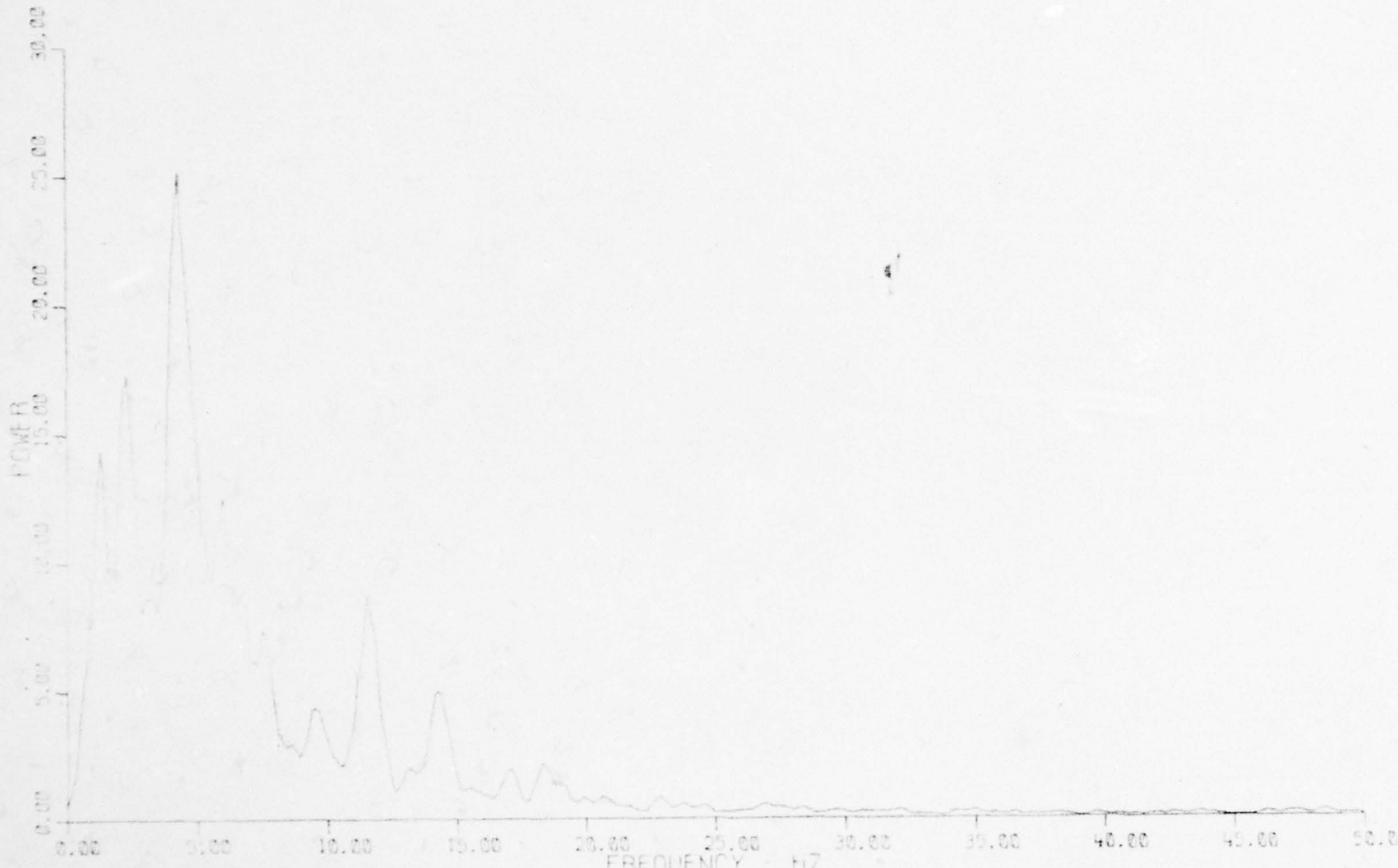
POST-EVENT **(30 minutes)**

MAY 12, 1978 TIME 10 49 31

R.SEN-SEN ,
A0 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.

C35


POWER SPECTRUM VERSUS FREQUENCY
POST-EVENT (30 minutes)
MAY 12, 1978 TIME 10 49 31
L.SEN-SEN
AØ 3933
NYQUIST FREQUENCY 50.00 HZ.
FILTER BANDWIDTH 0.50 HZ.
FREQUENCY - HZ
POWER
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
2.00
4.00
6.00
8.00
10.00
12.00



POWER SPECTRUM VERSUS FREQUENCY

POST-EVENT (30 minutes)

MAY 12, 1978, TIME 10 49 31

L.MOT-SEN

AØ 3933

NYQUIST FREQUENCY 50.00 HZ.

Figures D1 - D36

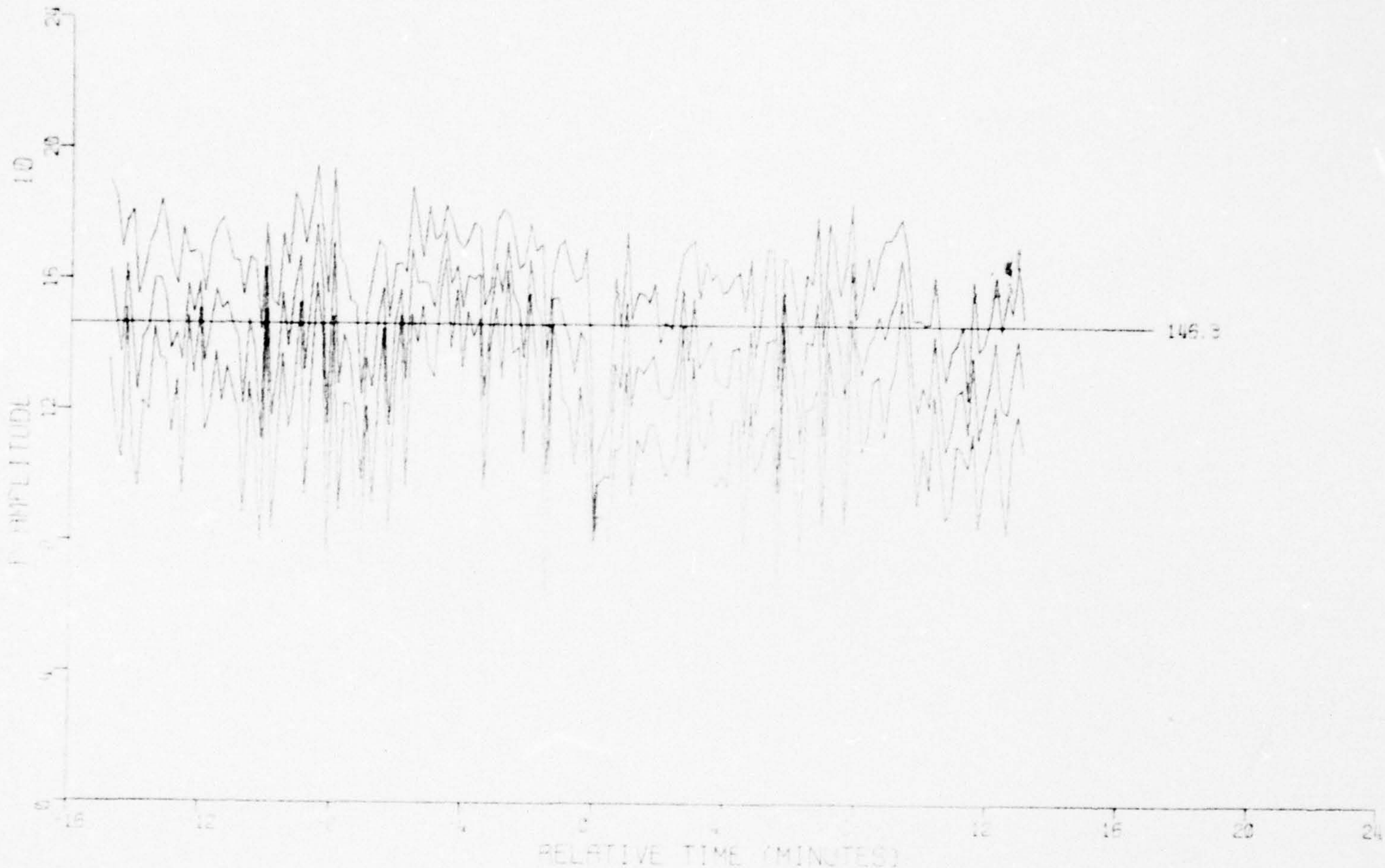
Evoked Potential Tracking Plots

FIGURE D 1

ANIMAL A-0761 RUN LX-3006 ACCELERATION 20.0 G
STIMULUS SITE 5. SPINE RATE 4.87 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC
RELATIVE TIME (MINUTES)
0.0

ANIMAL A-0761   RUN LX-3006   ACCELERATION 20.0 G
STIMULUS SITE 5. SPINE   RATE 4.67 /SEC
RECORDING SITE 1. MX   NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 2



ANIMAL A-0761 RUN LX-3006 ACCELERATION 20.0 G

STIMULUS SPINE RATE 4.67 /SEC

RECORDING SITE 1. MX NBR. AVERAGED 5

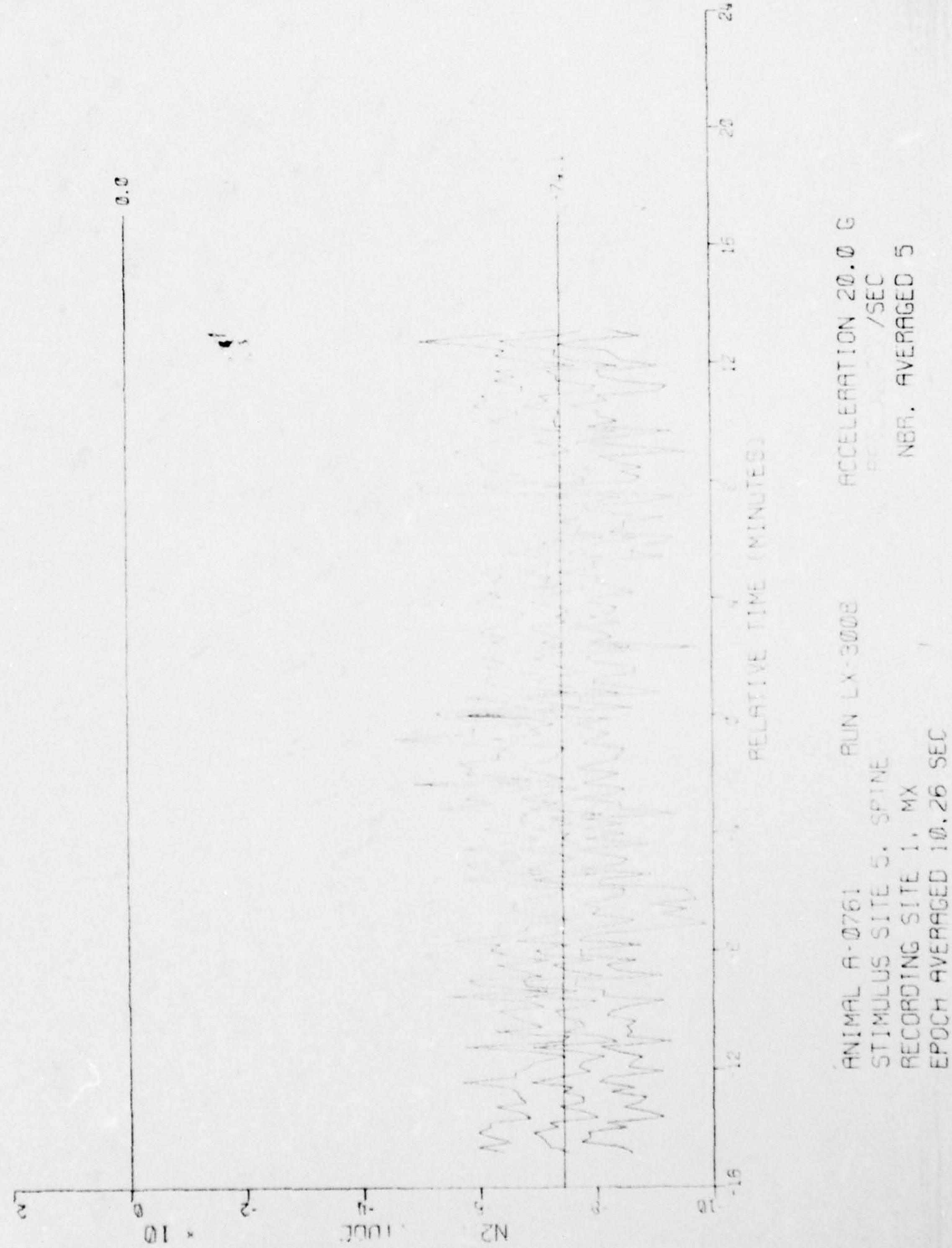
EPOCH AVERAGED 10.26 SEC

FIGURE D 3

FIGURE D 4

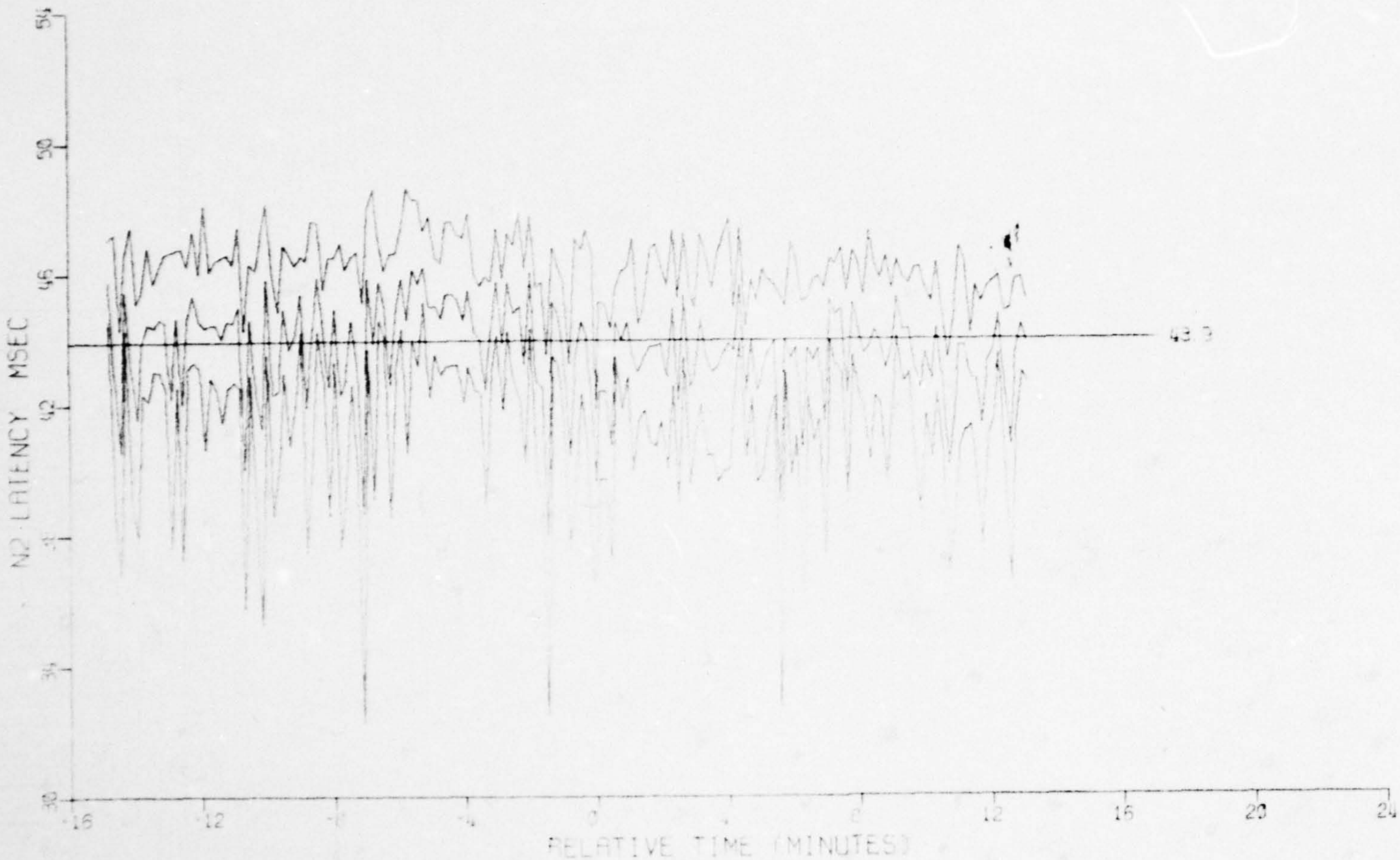
ANIMAL A-Ø761 RUN LX-3006 ACCELERATION 2Ø.Ø G
STIMULUS SITE 5. SPINE RATE 4.87 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 1Ø.26 SEC

FIGURE D 5



0.0
RELATIVE TIME (MINUTES)
-16
-12
-8
-4
0
4
8
12
16
20
24
2
0
-2
-4
-6
-8
-10
× 10
ANIMAL A-0761 RUN LX-3008 ACCELERATION 20.0 G
STIMULUS SITE 5, SPINE /SEC
RECORDING SITE 1, MX NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

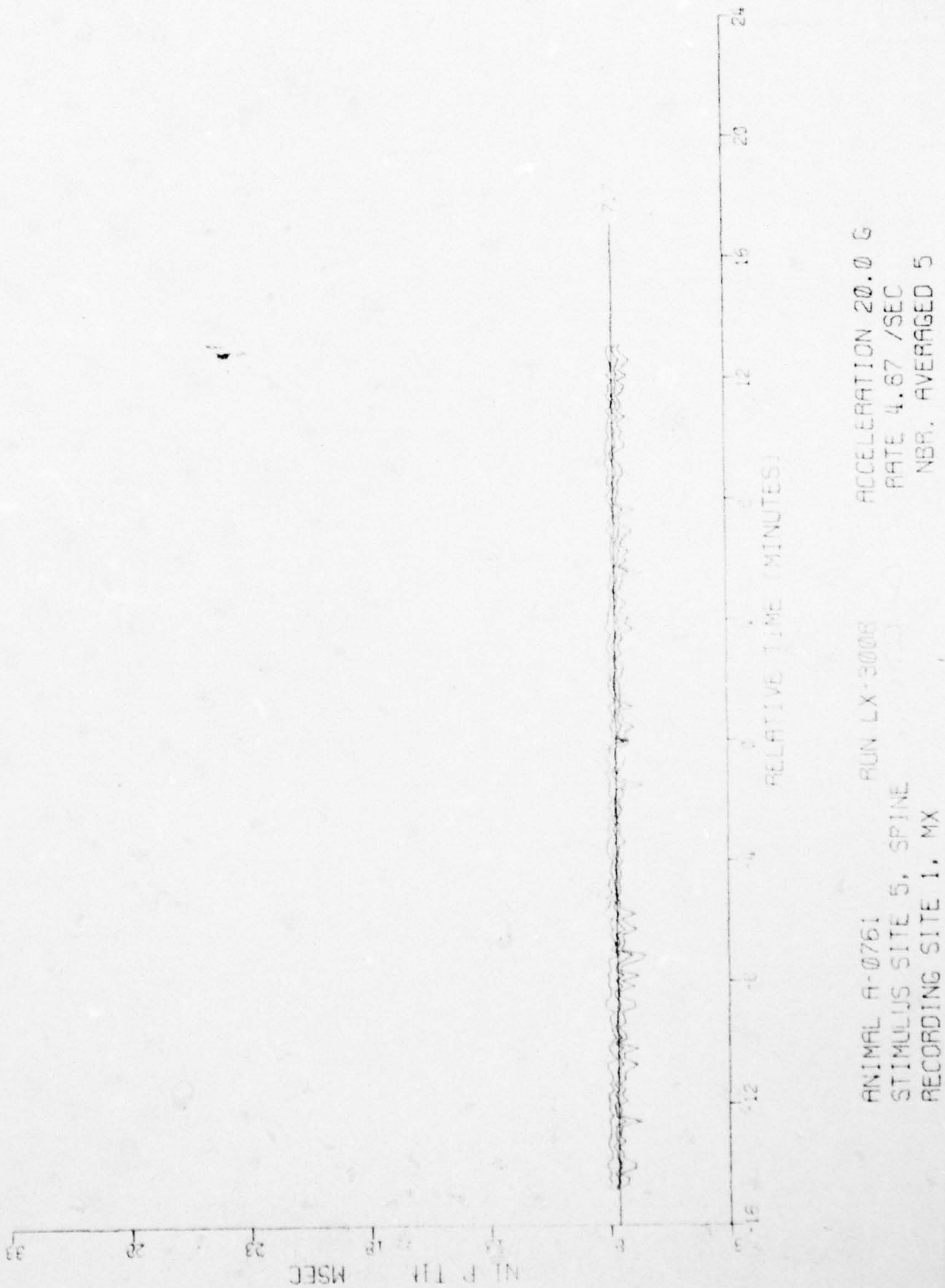
FIGURE D 6



ANIMAL A-0761 RUN LX-3008
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC

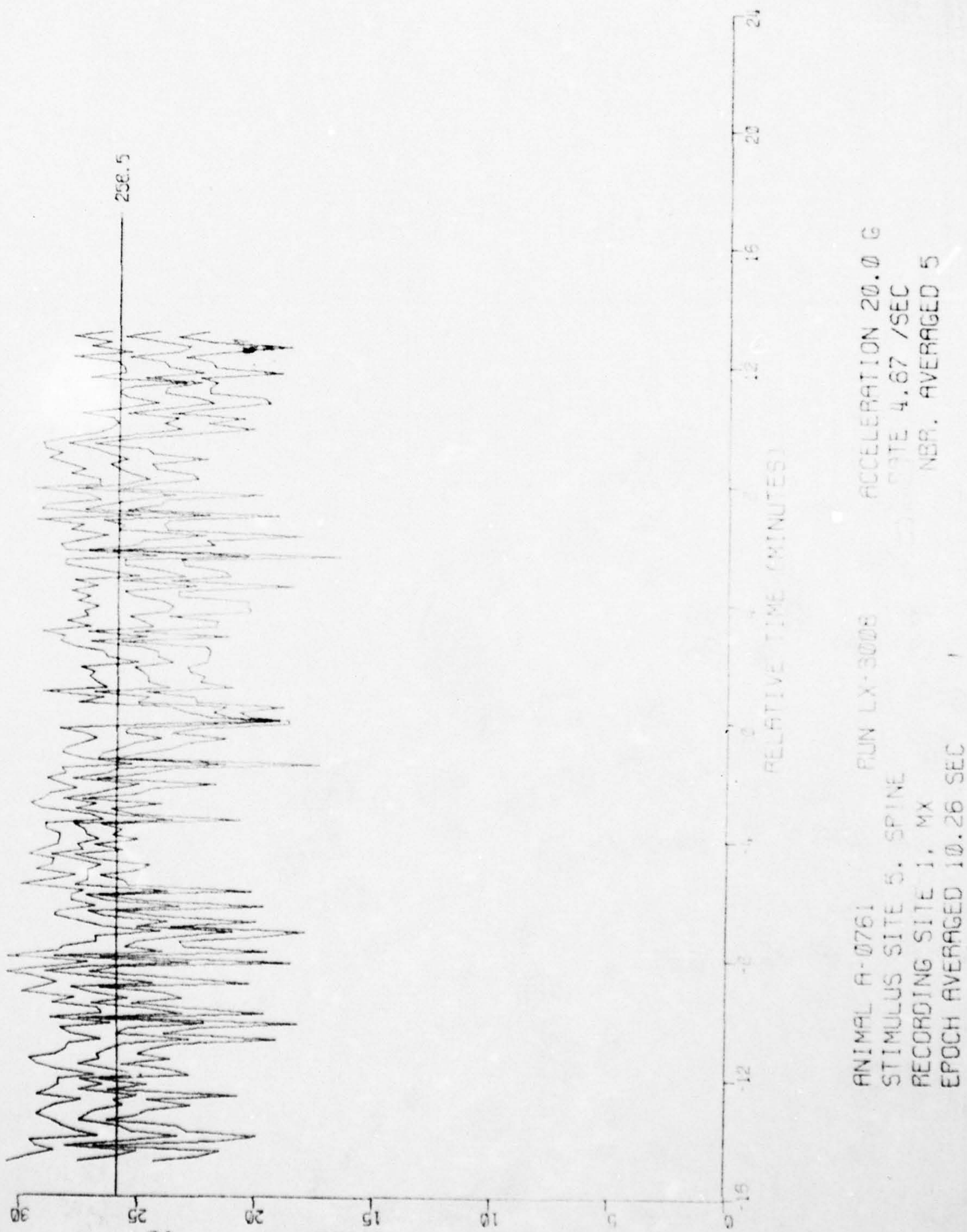
ACCELERATION 20.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 7



ANIMAL A-0761
RUN LX-3008
STIMULUS SITE 5, SPINE
RECORDING SITE 1, MX
EPOCH AVERAGED 10.26 SEC
ACCELERATION 20.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5
RELATIVE TIME (MINUTES)
MSEC
-16
-12
-8
-4
0
4
8
12
16
20
24

FIGURE D 8



258.5
RELATIVE TIME (MINUTES)
ANIMAL A-0761
RUN LX-3008
ACCELERATION 20.0 G
STIMULUS SITE 5. SPINE
RATE 4.67 /SEC
RECORDING SITE 1. MX
NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 9

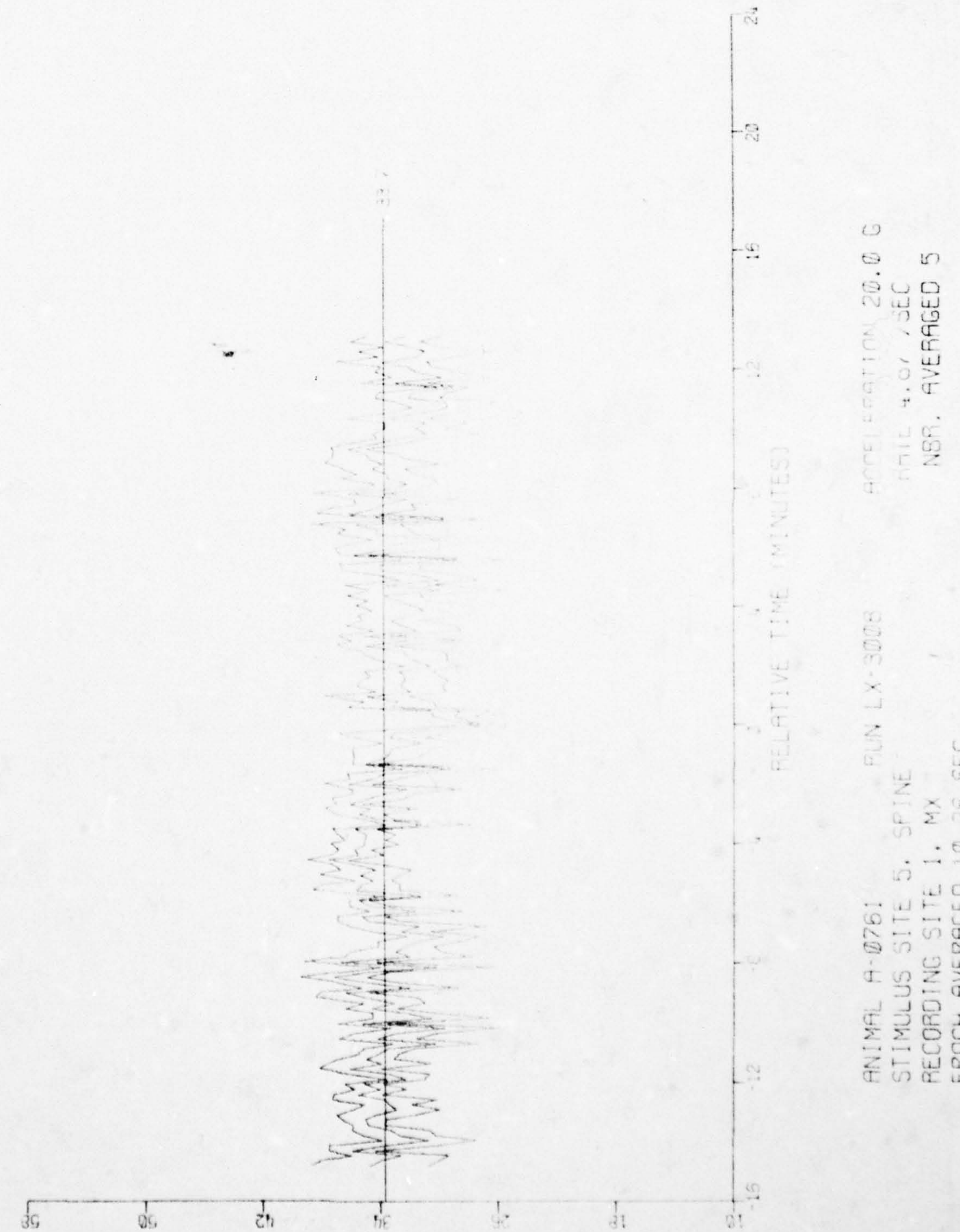

RELATIVE TIME (MINUTES)
ANIMAL A-0761
RUN LX-3008
ACCELERATION 20.0 G
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 10

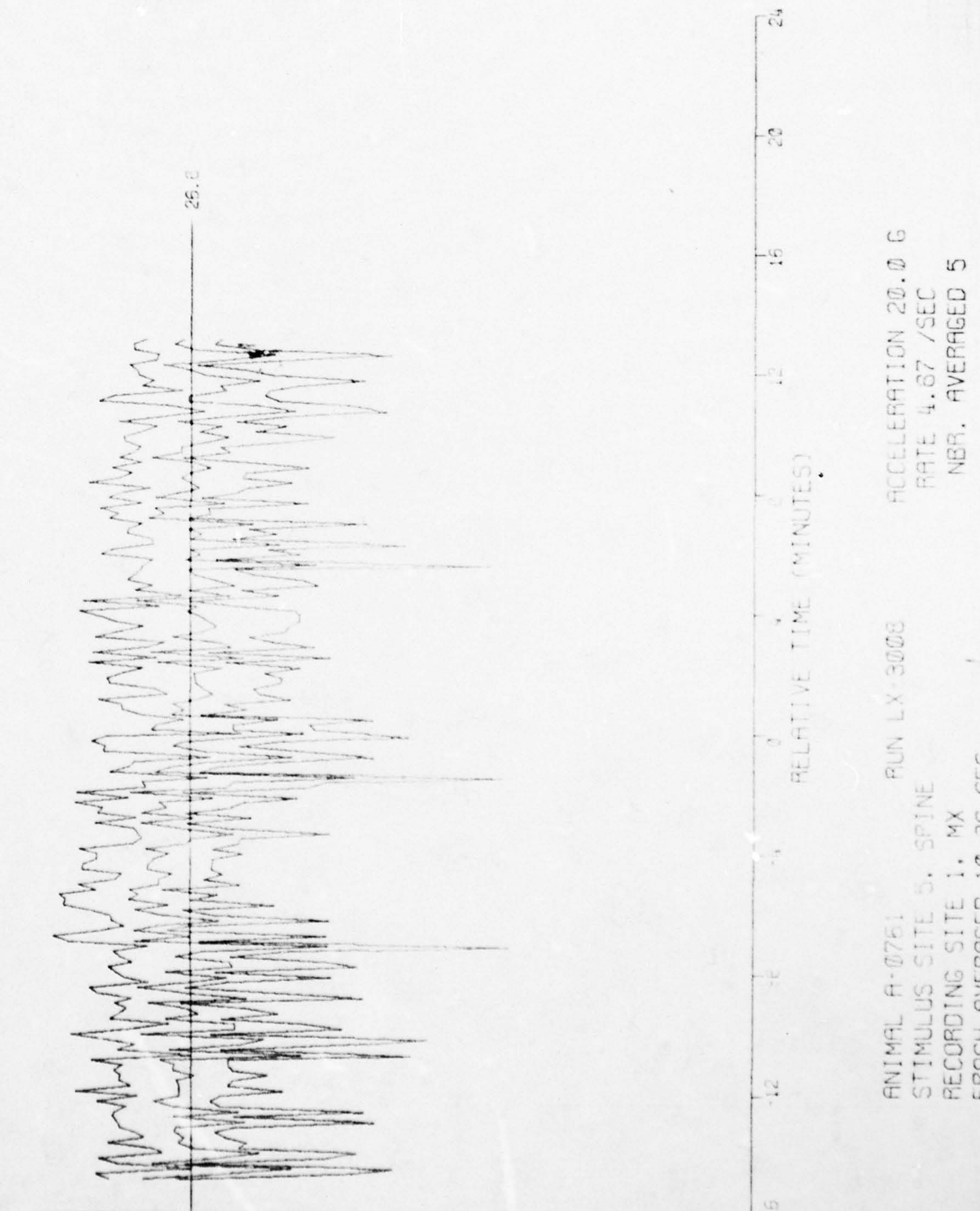
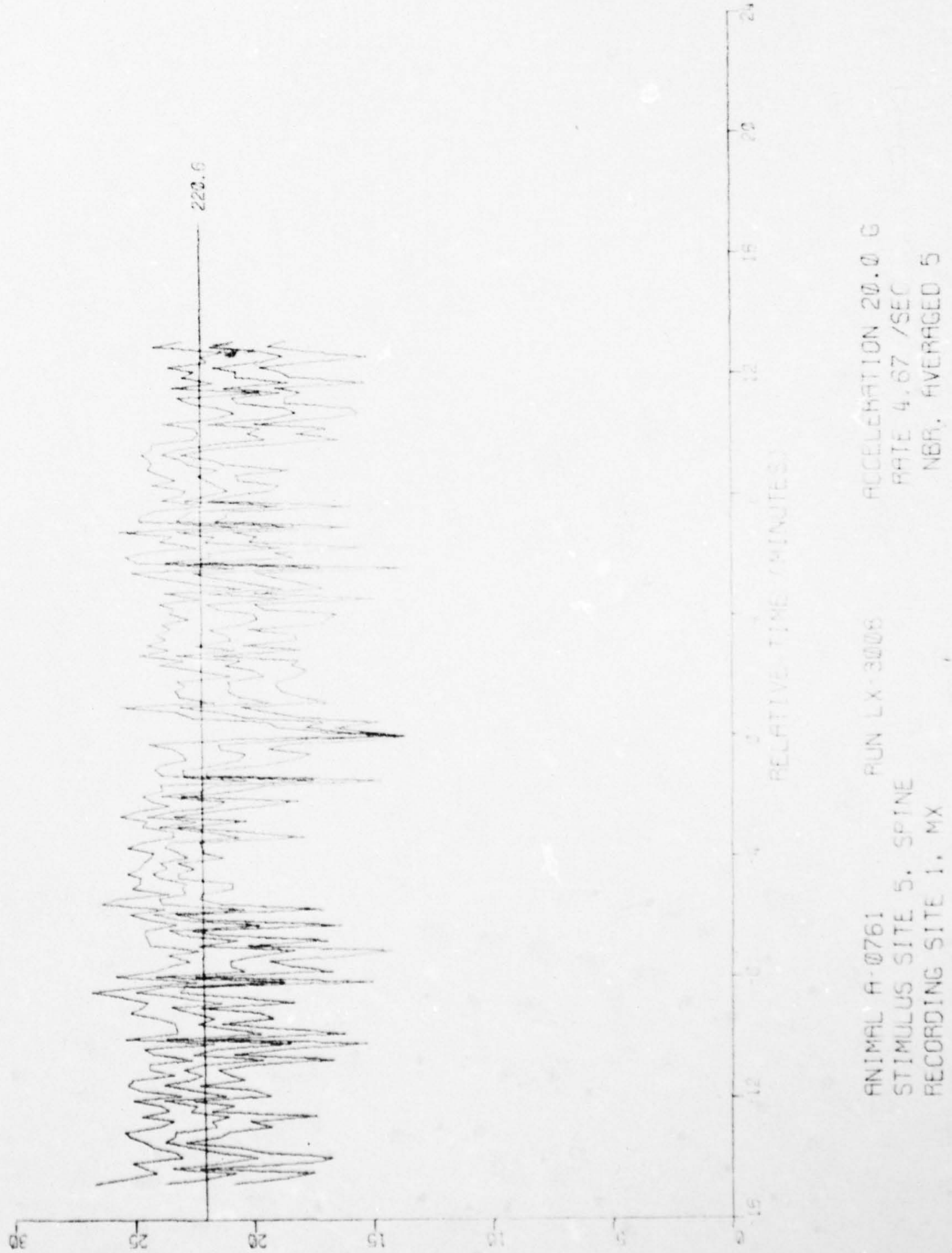

26.0
RELATIVE TIME (MINUTES)
ANIMAL A-0761 RUN LX-3008
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
ACCELERATION 20.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 11



220.6
P N2 AMPLITUDE × 10
RELATIVE TIME (MINUTES)
ANIMAL A-Ø761 RUN LX-3008 ACCELERATION 2Ø.Ø G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 1Ø.25 SEC

AD-A073 071 TEXAS RESEARCH INST OF MENTAL SCIENCES HOUSTON F/G 6/16
ANALYSIS OF ELECTROPHYSIOLOGICAL SIGNALS FROM ANIMALS SUBJECTED--ETC(U)
AUG 79 B SALTZBERG, W D BURTON N00014-76-C-0911

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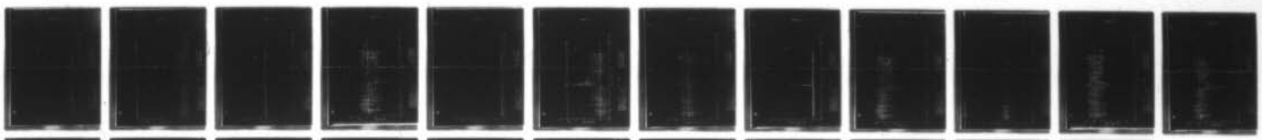
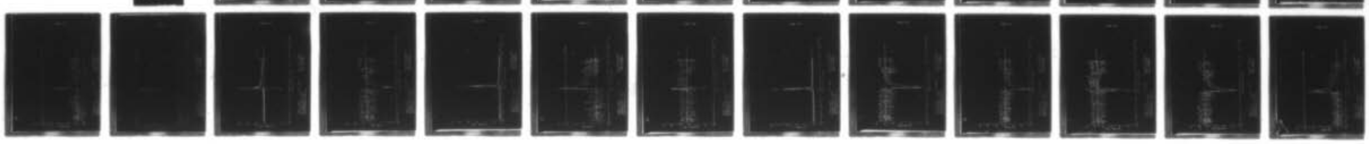




END
DATE
FILMED
9-79
DDC

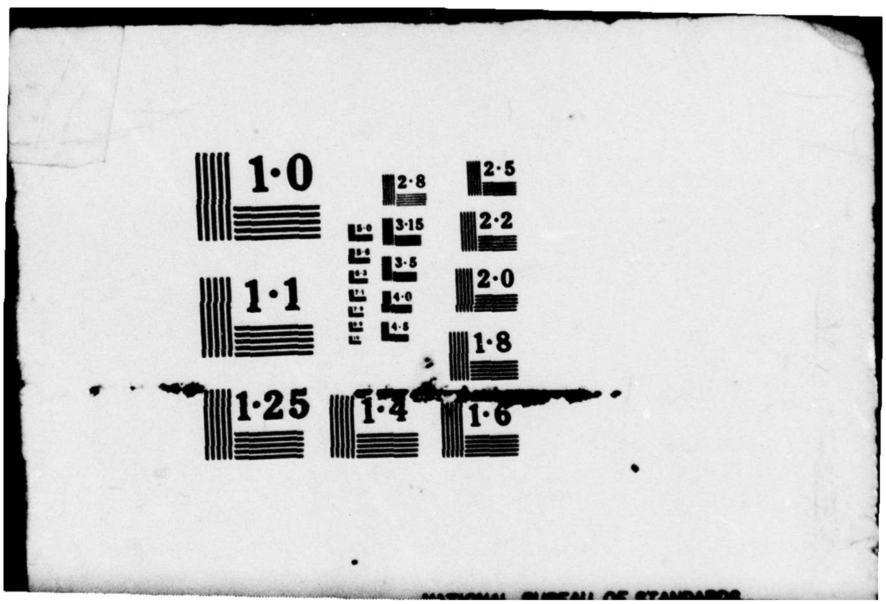

1·0
2·8
2·5
3·15
2·2
3·5
2·0
4·0
1·1
4·5
1·8
1·25
1·4
1·6

FIGURE D 12

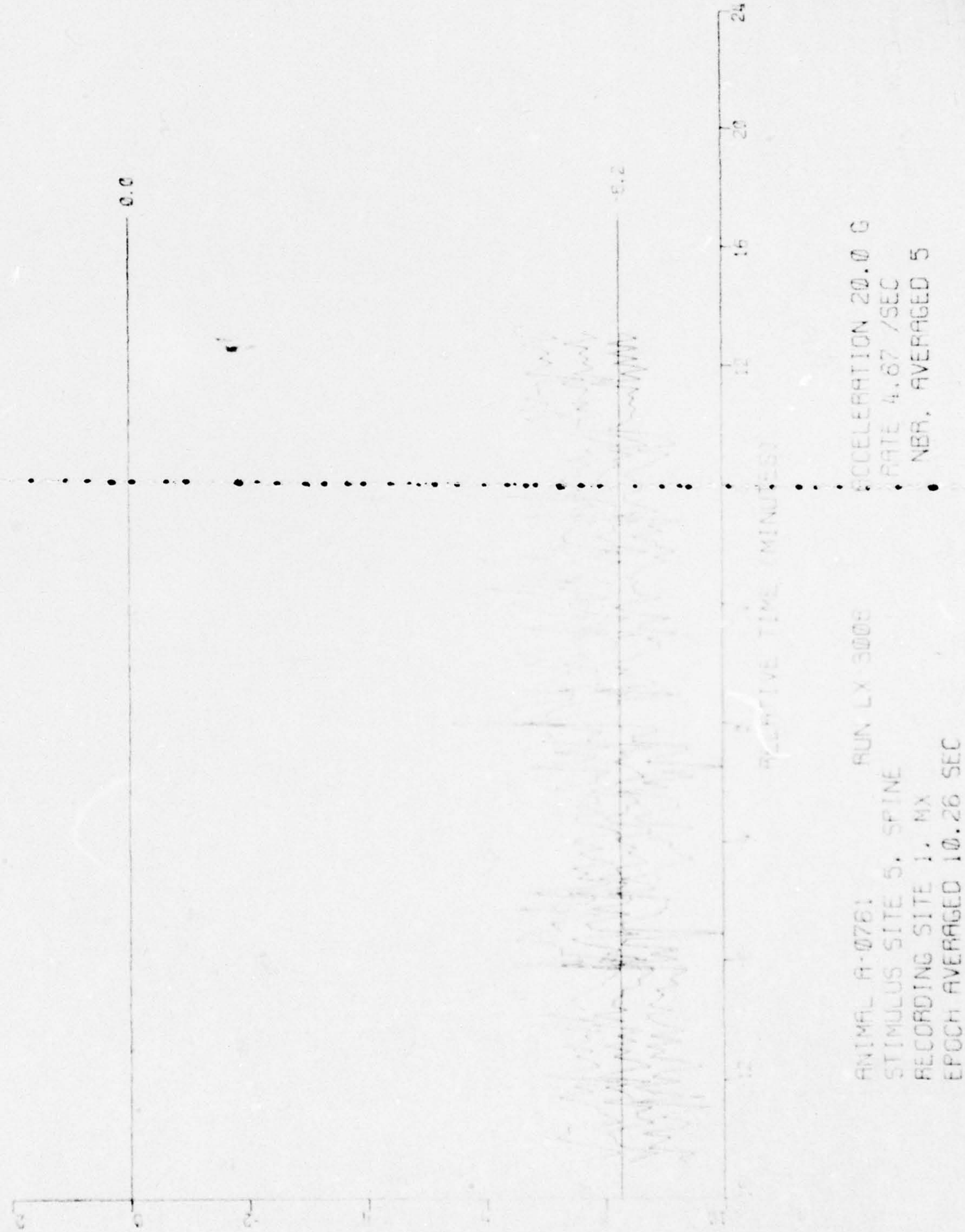
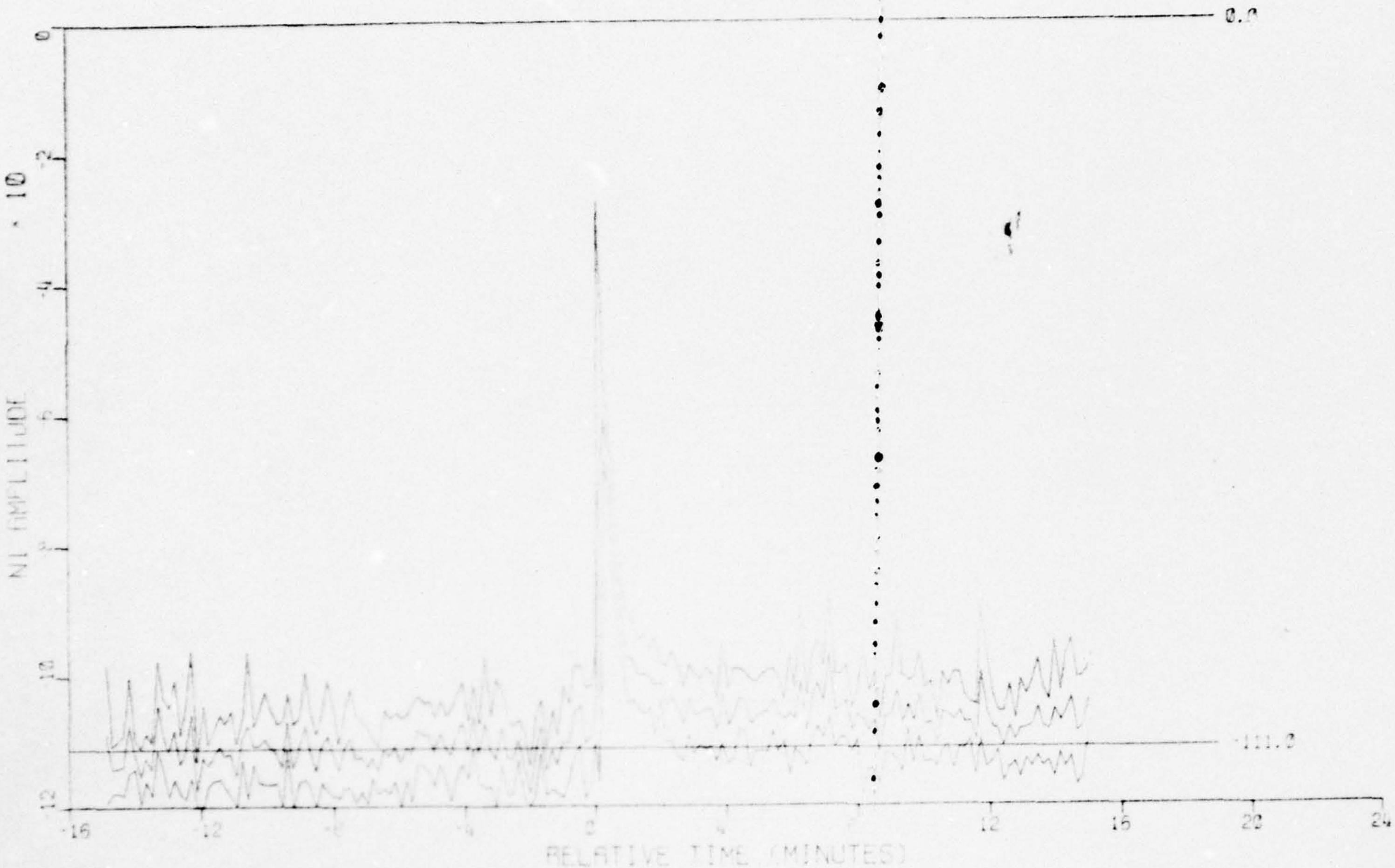

ANIMAL A-0761 RUN LX 3008
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
ACCELERATION 20.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5
RELATIVE TIME (MINUTES)

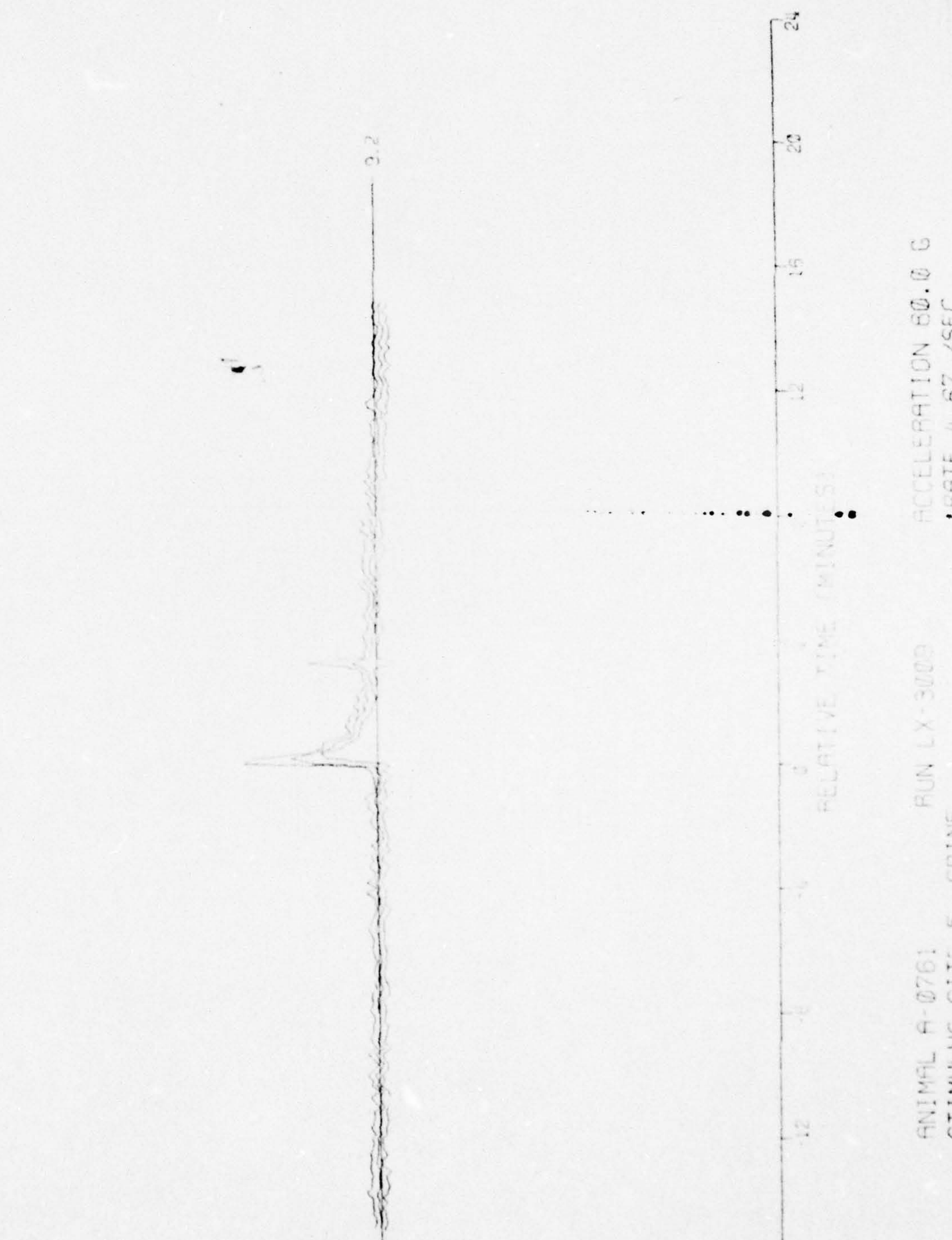
FIGURE D 13



ANIMAL A-Ø761 RUN LX-3ØØ9
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 1Ø.27 SEC

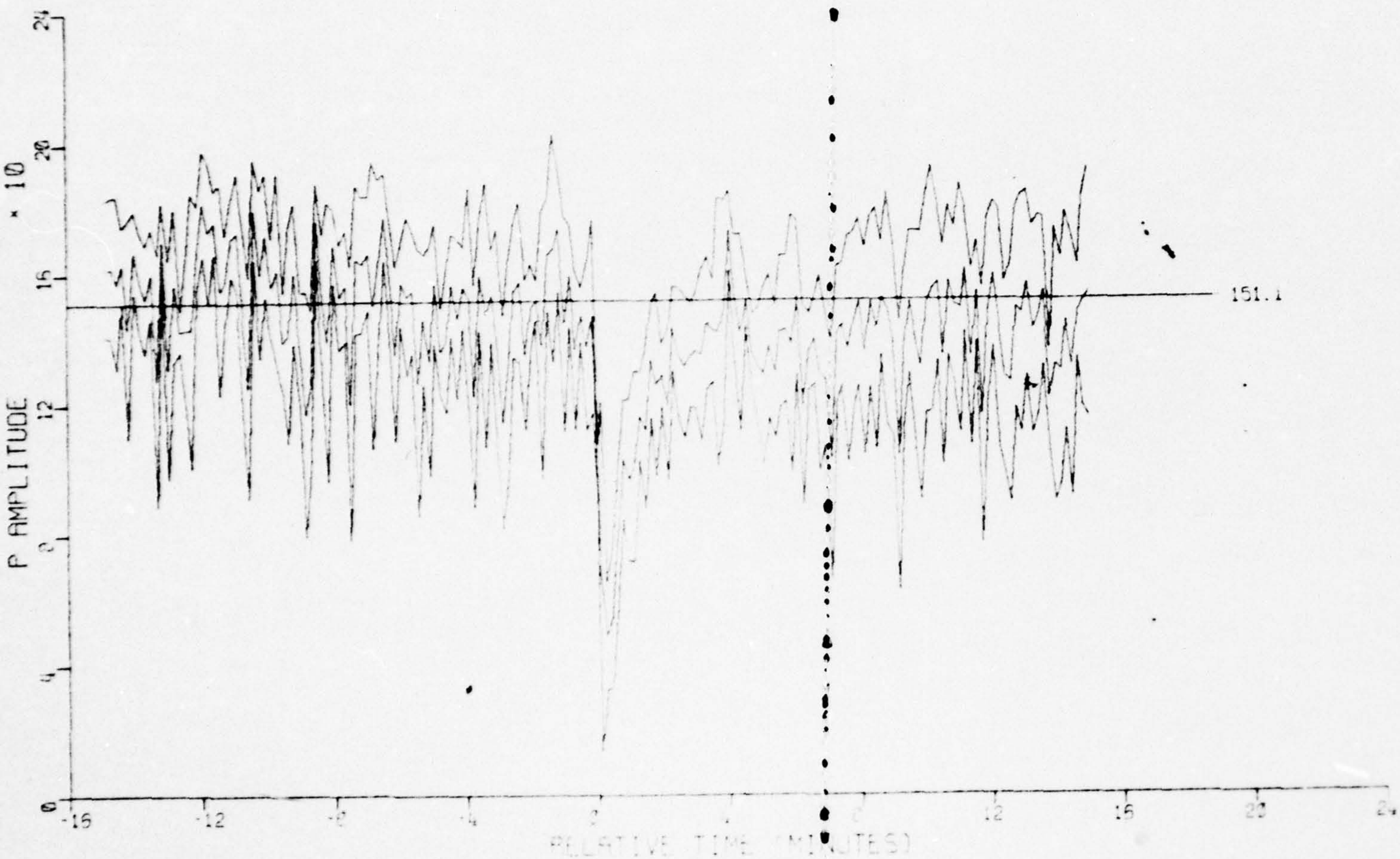
ACCELERATION 8Ø.Ø G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 14



N1 LATENCY MSEC
RELATIVE TIME (MINUTES)
ANIMAL A-0761 RUN LX-3009
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.27 SEC
ACCELERATION 80.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

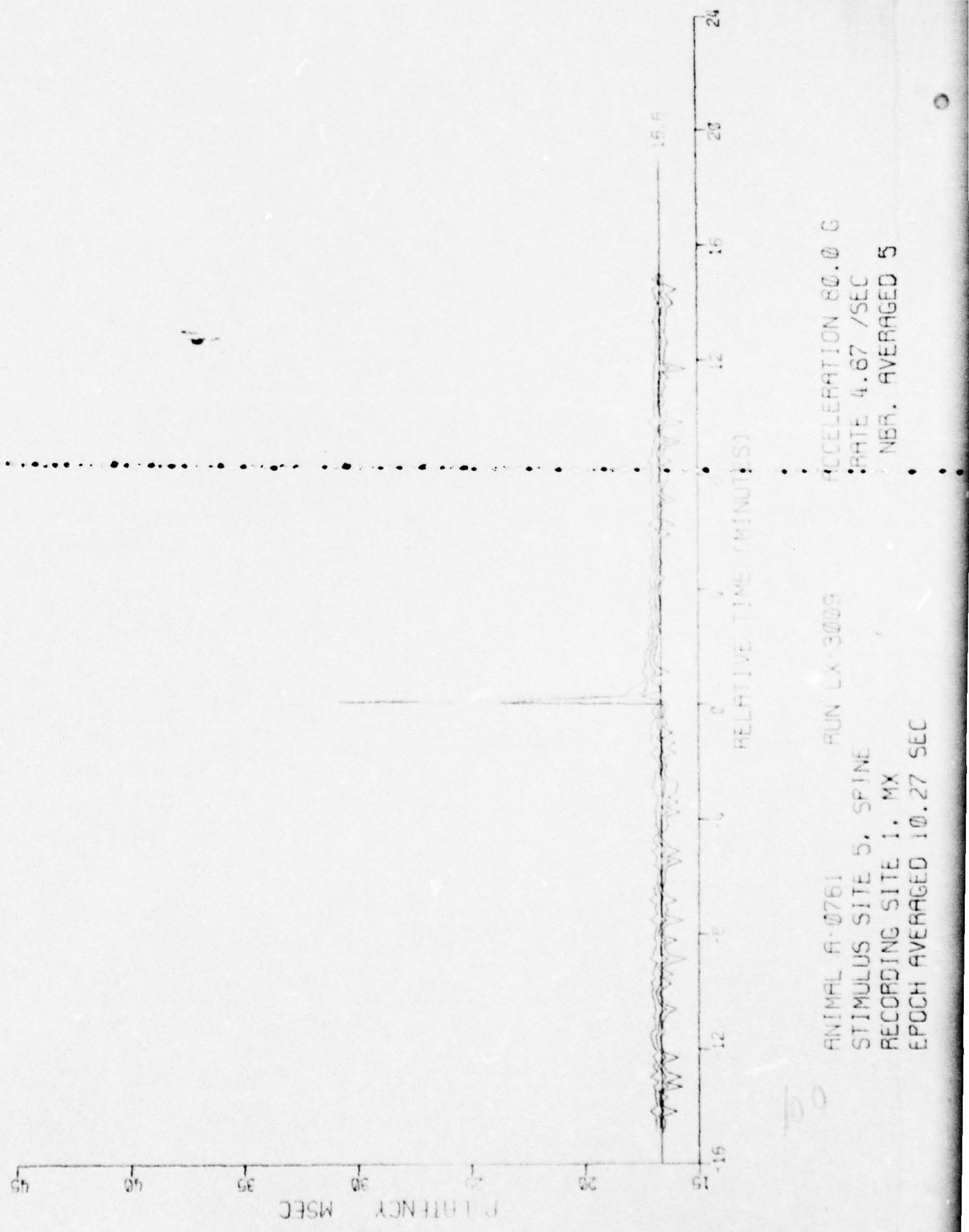
FIGURE D 15



ANIMAL A-0761 RUN LX-3009
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.27 SEC

ACCELERATION 60.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 16



ANIMAL A-0761 RUN LX-3009
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.27 SEC
ACCELERATION 80.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5
RELATIVE TIME (MINUTES)
LATENCY MSEC

FIGURE D 17

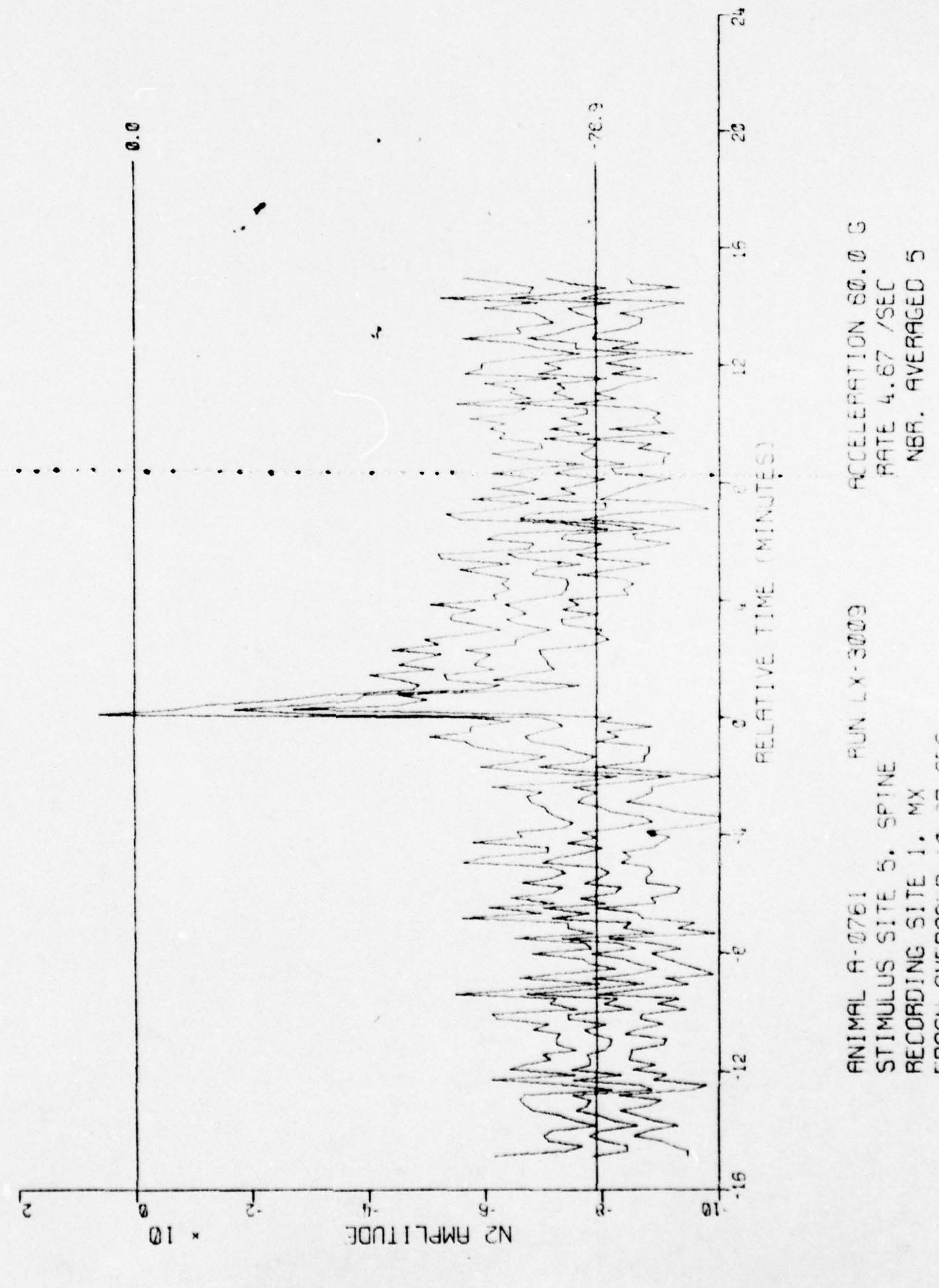
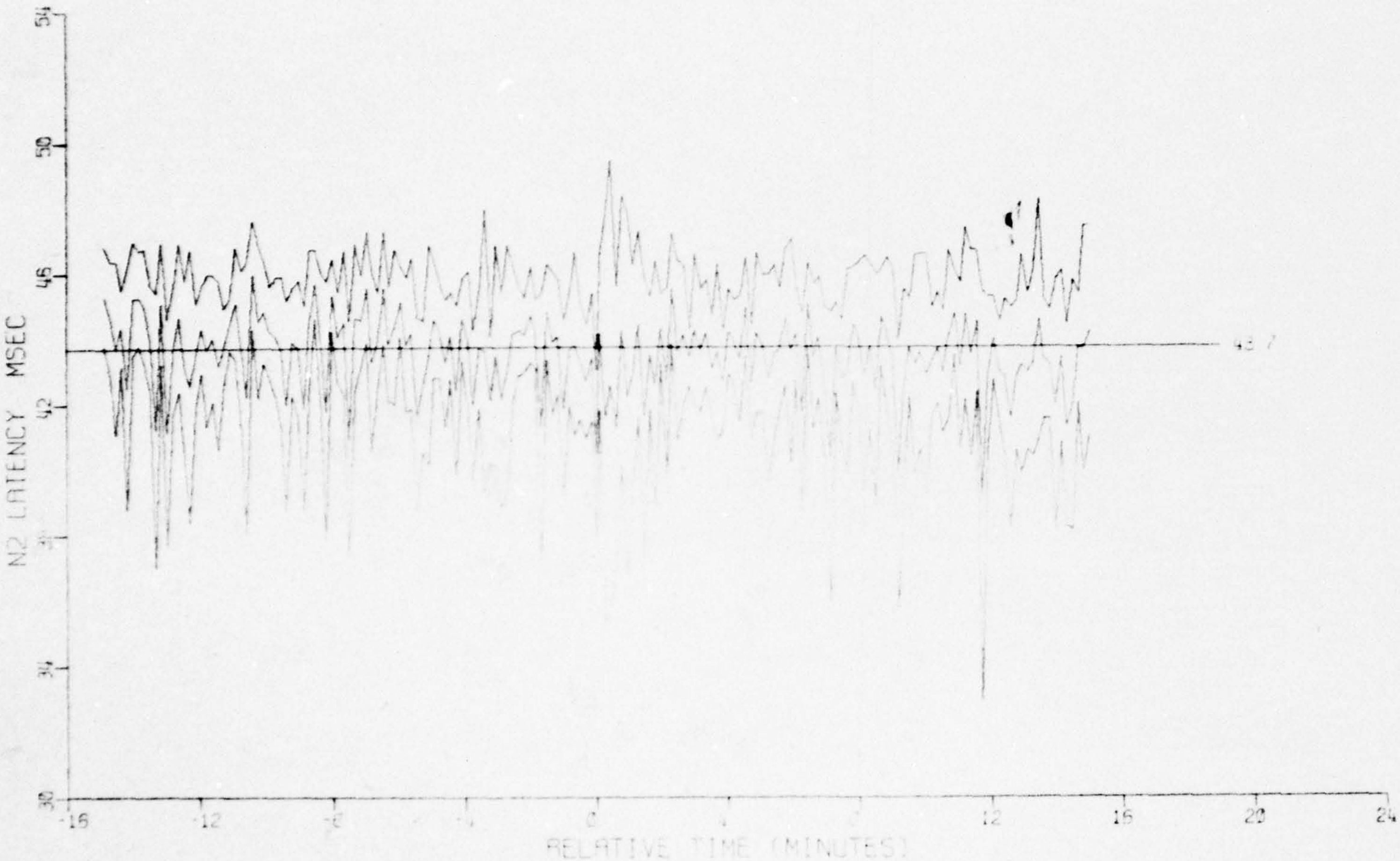

N2 AMPLITUDE × 10
RELATIVE TIME (MINUTES)
0.0
-78.9
ANIMAL A-0761 RUN LX-3009 ACCELERATION 60.0 G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.27 SEC

FIGURE D 18



ANIMAL A-Ø761   RUN LX-3ØØ9   ACCELERATION 8Ø.Ø G
STIMULUS SITE 5. SPINE   RATE 4.67 /SEC
RECORDING SITE 1. MX   NBR. AVERAGED 5
EPOCH AVERAGED 1Ø.27 SEC

FIGURE D 19

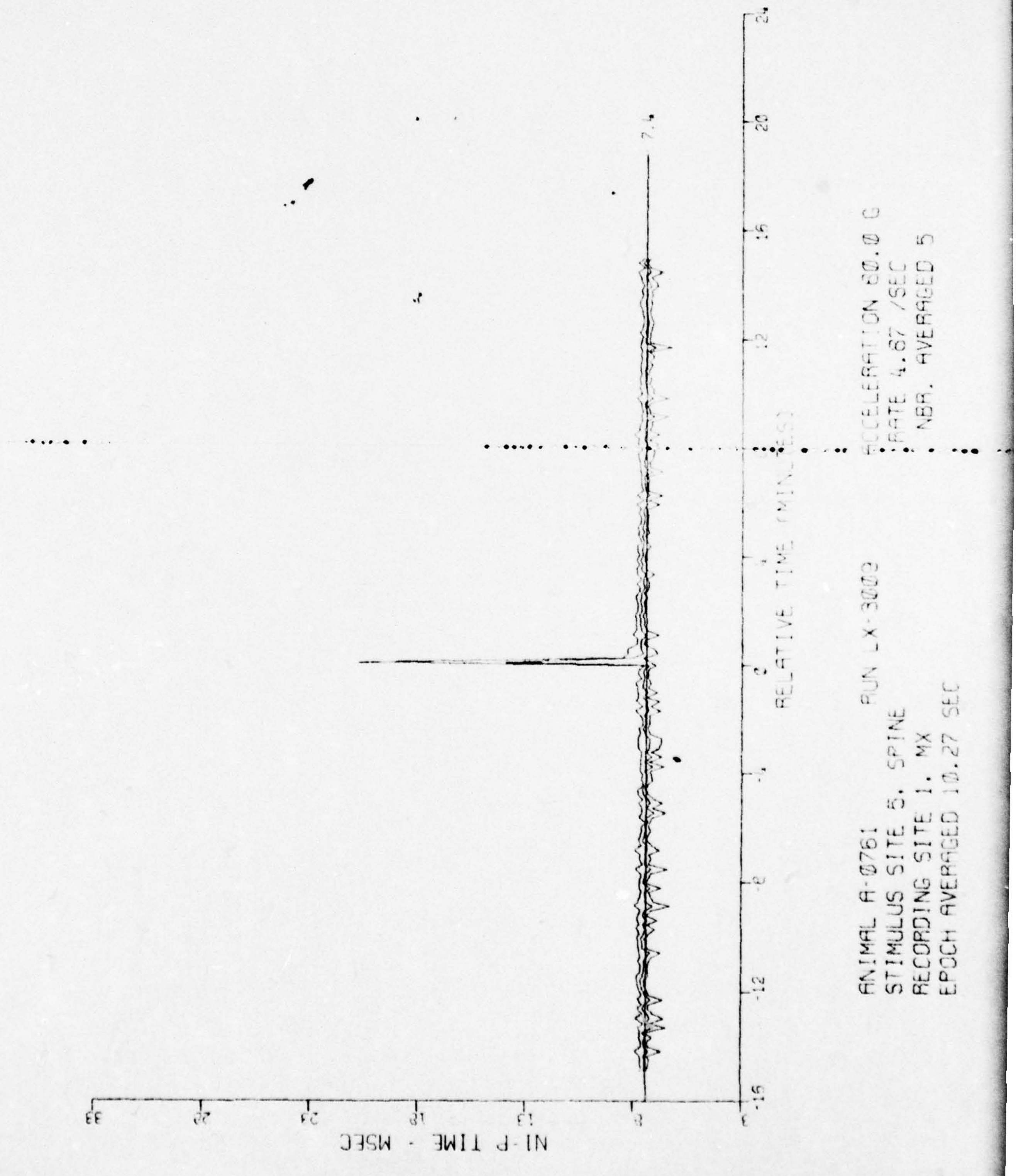
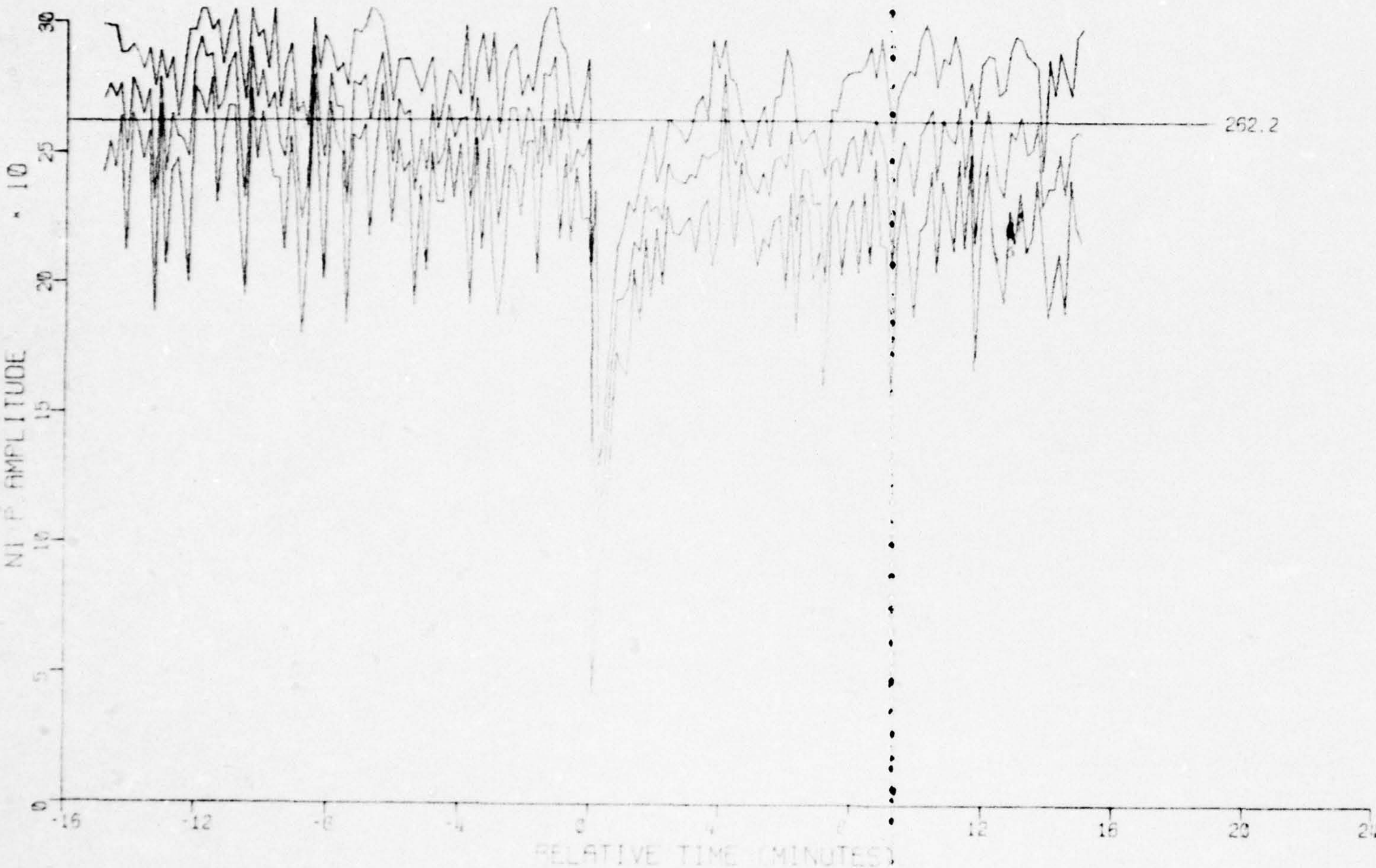

ANIMAL A-0761
RUN LX-3000
ACCELERATION 60.0 G
STIMULUS SITE 5, SPINE
RATE 4.67 /SEC
RECORDING SITE 1, MX
NBR. AVERAGED 5
EPOCH AVERAGED 10.27 SEC
RELATIVE TIME (MINUTES)
N1-P TIME - MSEC

FIGURE D.20



ANIMAL A-0761 RUN LX-3069 ACCELERATION 80.0 G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.27 SEC

FIGURE D 21

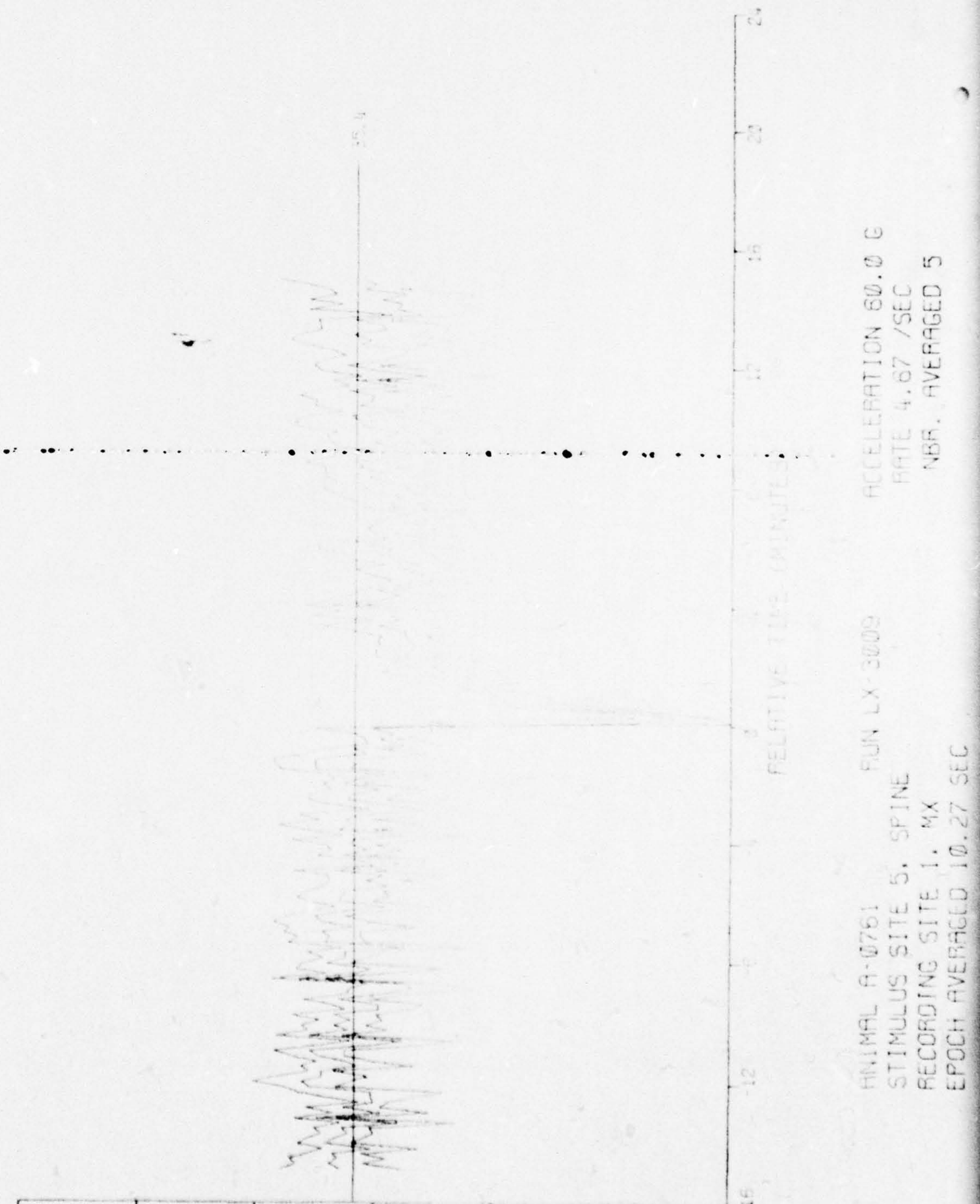

ANIMAL A-Ø761
RUN LX-3ØØ9
ACCELERATION 6Ø.Ø G
STIMULUS SITE 5. SPINE
RATE 4.67 /SEC
RECORDING SITE 1. MX
NBR. AVERAGED 5
EPOCH AVERAGED 1Ø.27 SEC
RELATIVE TIME (MINUTES)
IN

FIGURE D 22

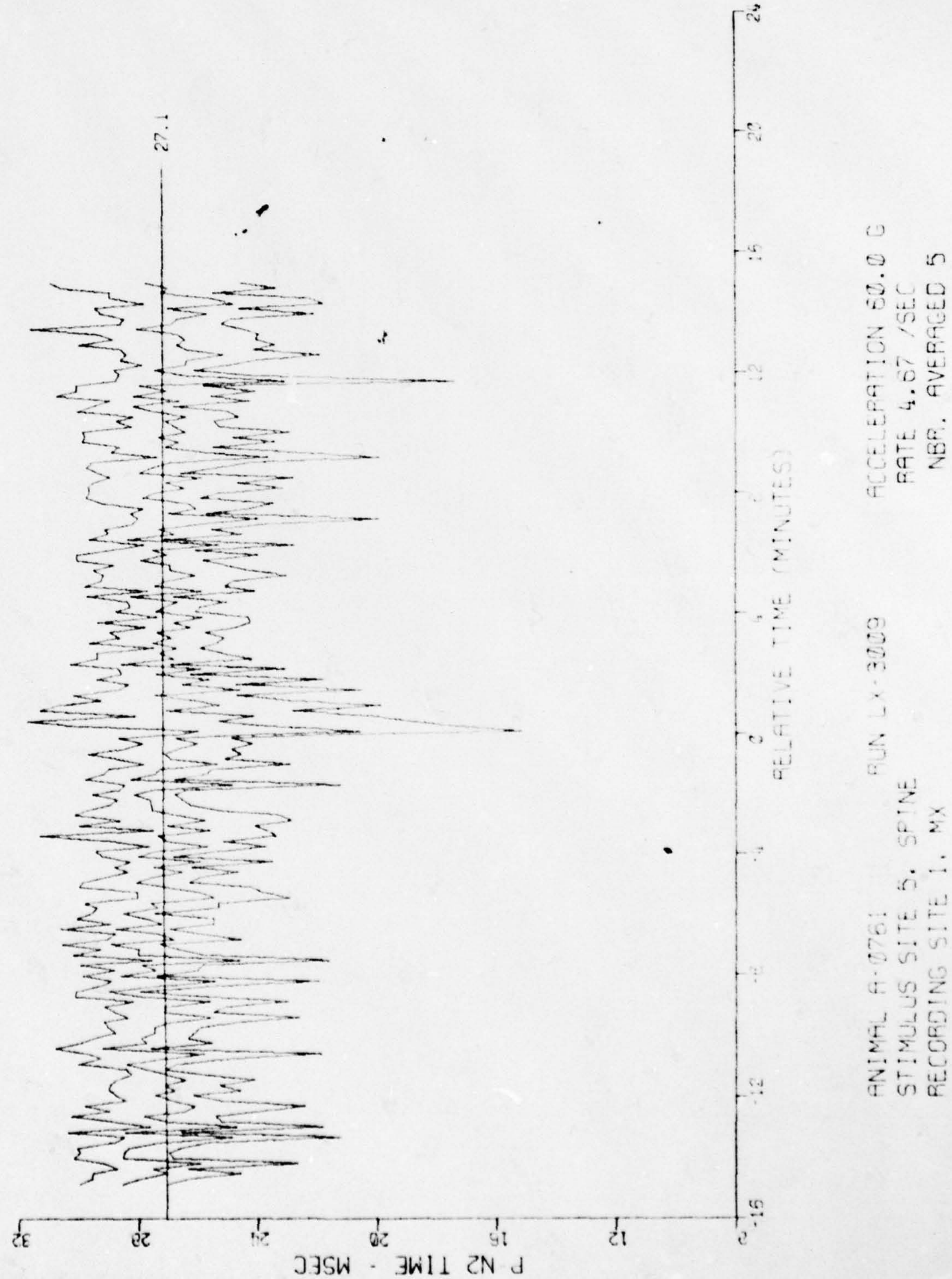
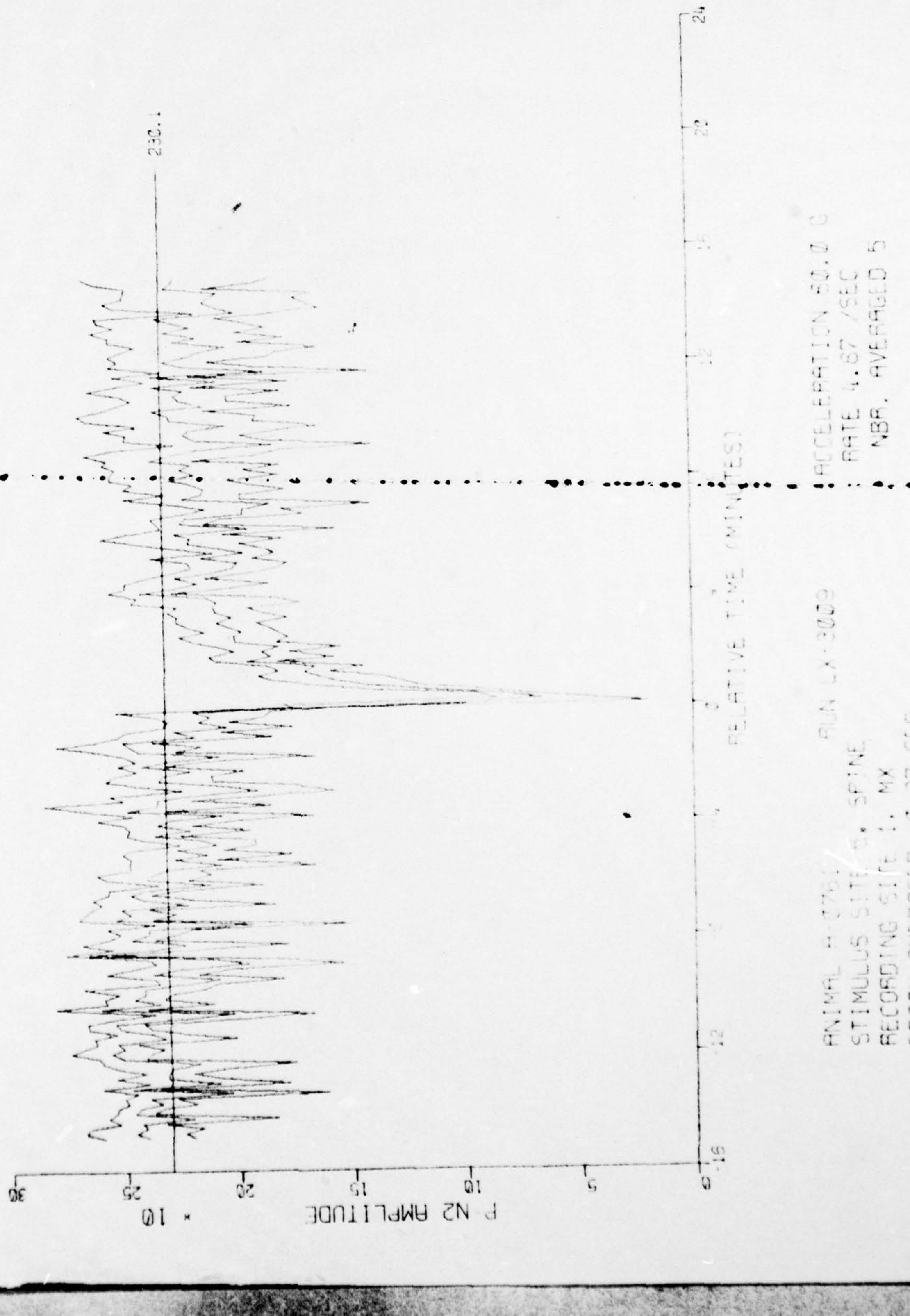

P N2 TIME - MSEC
RELATIVE TIME (MINUTES)
27.1
ANIMAL A-0761
RUN LX-3009
STIMULUS SITE 5, SPINE
RECORDING SITE 1, MX
EPOCH AVERAGED 10.27 SEC
ACCELERATION 60.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 23



P-N2 AMPLITUDE × 10
RELATIVE TIME (MINUTES)
RUN LX-3009
SPINE
RECORDING SITE 1, MX
EPOCH AVERAGED 10.27 SEC
ACCELERATION 50.0 G
RATE 4.87 /SEC
NBR, AVERAGED 5

FIGURE D 24

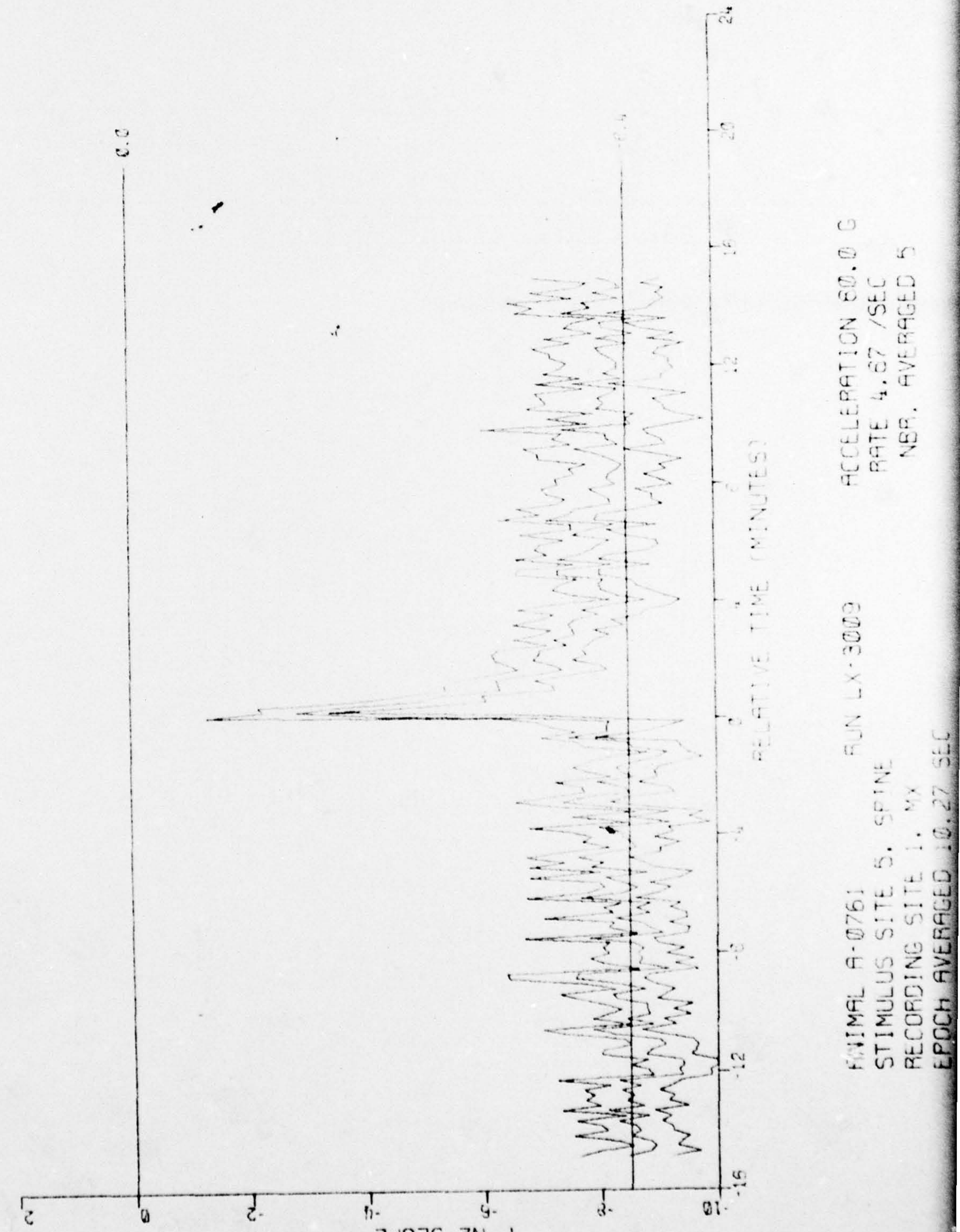
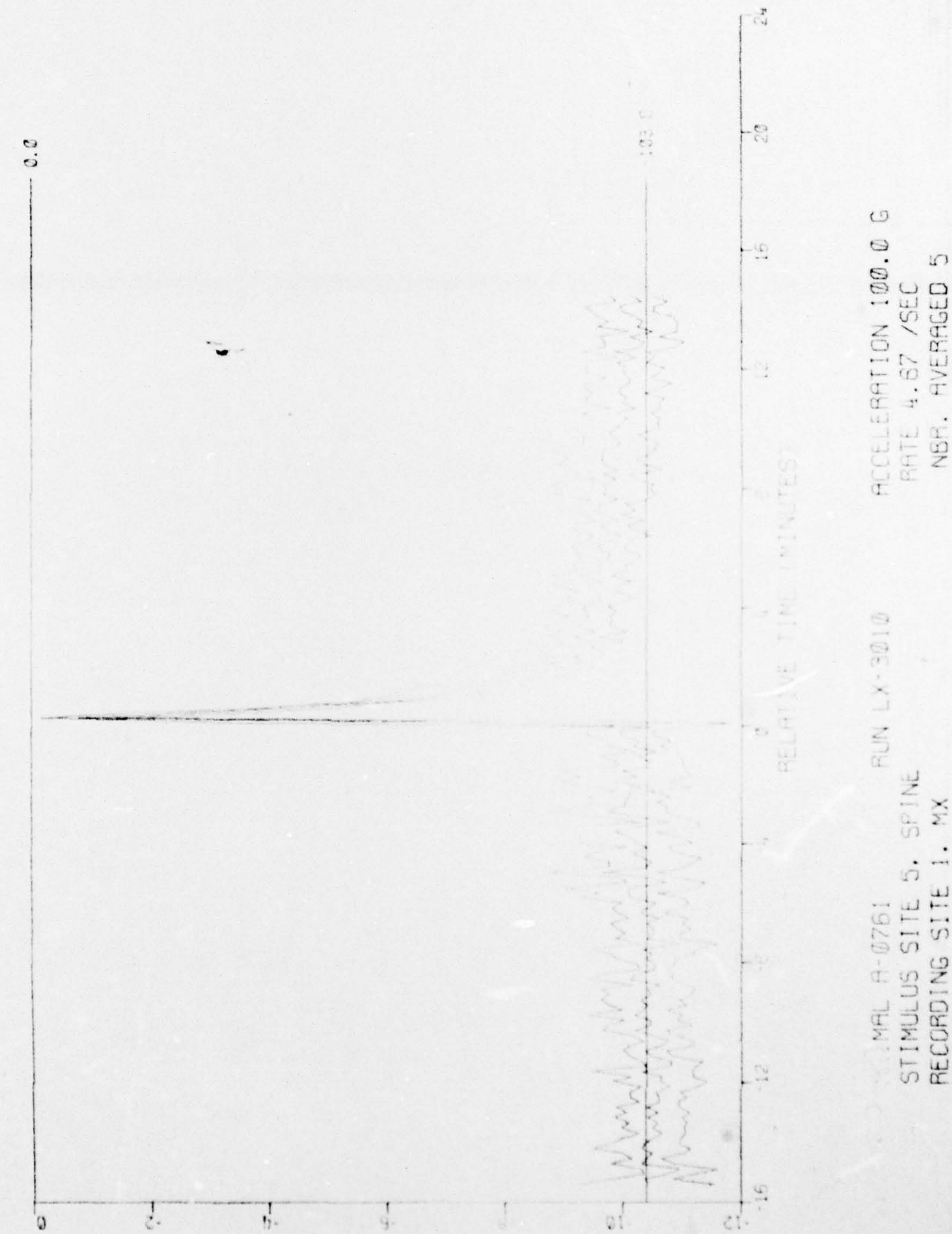
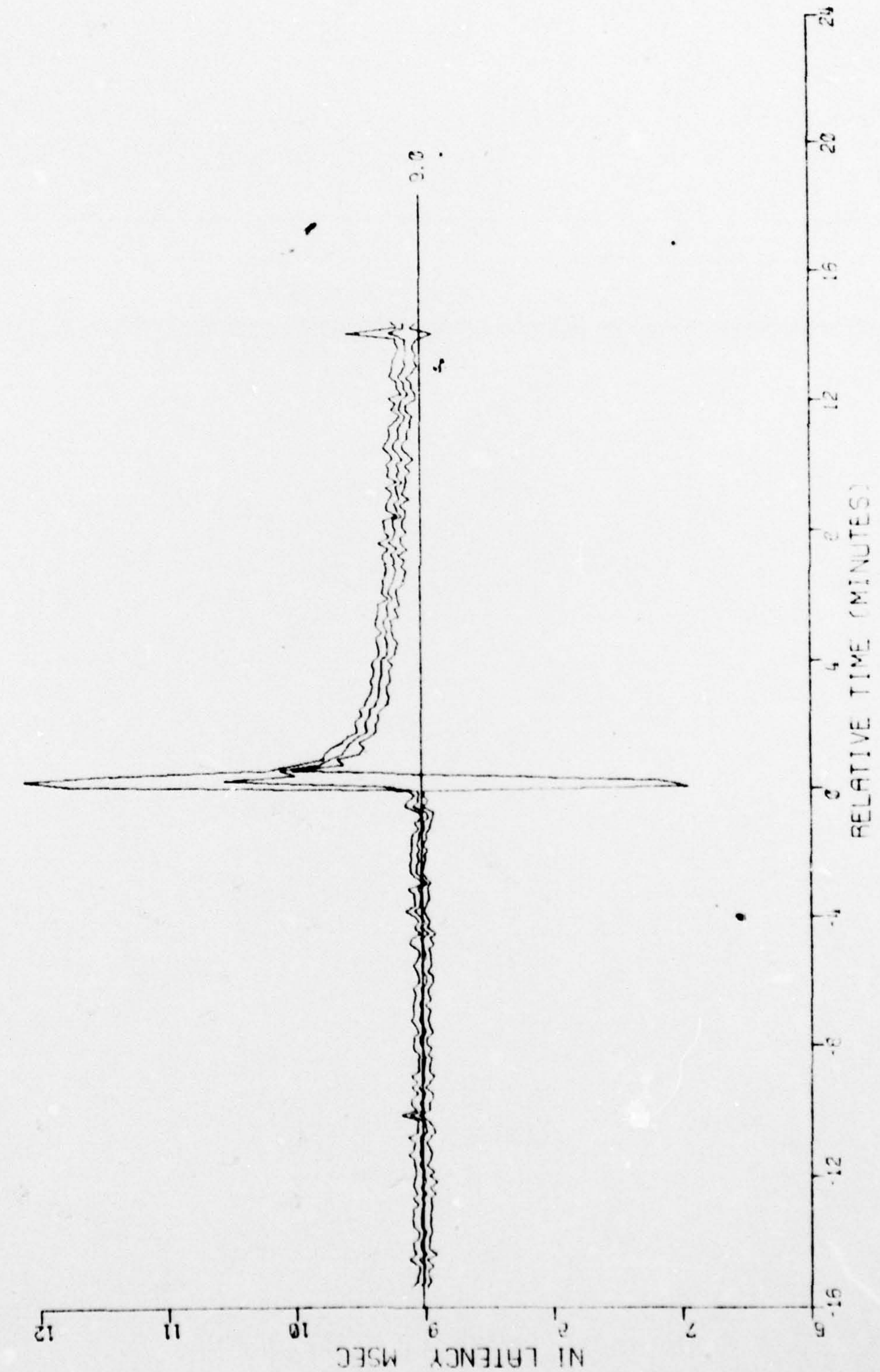

P-N2 SLOPE
RELATIVE TIME (MINUTES)
ANIMAL A-0761
RUN LX-3009
ACCELERATION 60.0 G
STIMULUS SITE 5. SPINE
RATE 4.67 /SEC
RECORDING SITE 1. MX
NBR. AVERAGED 5
EPOCH AVERAGED 10.27 SEC

FIGURE D 25



0.0
133.0
RELATIVE TIME (MINUTES)
NL AMPLITUDE × 10
ACCELERATION 100.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5
MAL A-0761 RUN LX-3010
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC

FIGURE D 26



ANIMAL A-0761 RUN LX-3010 ACCELERATION 100.0 G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 27

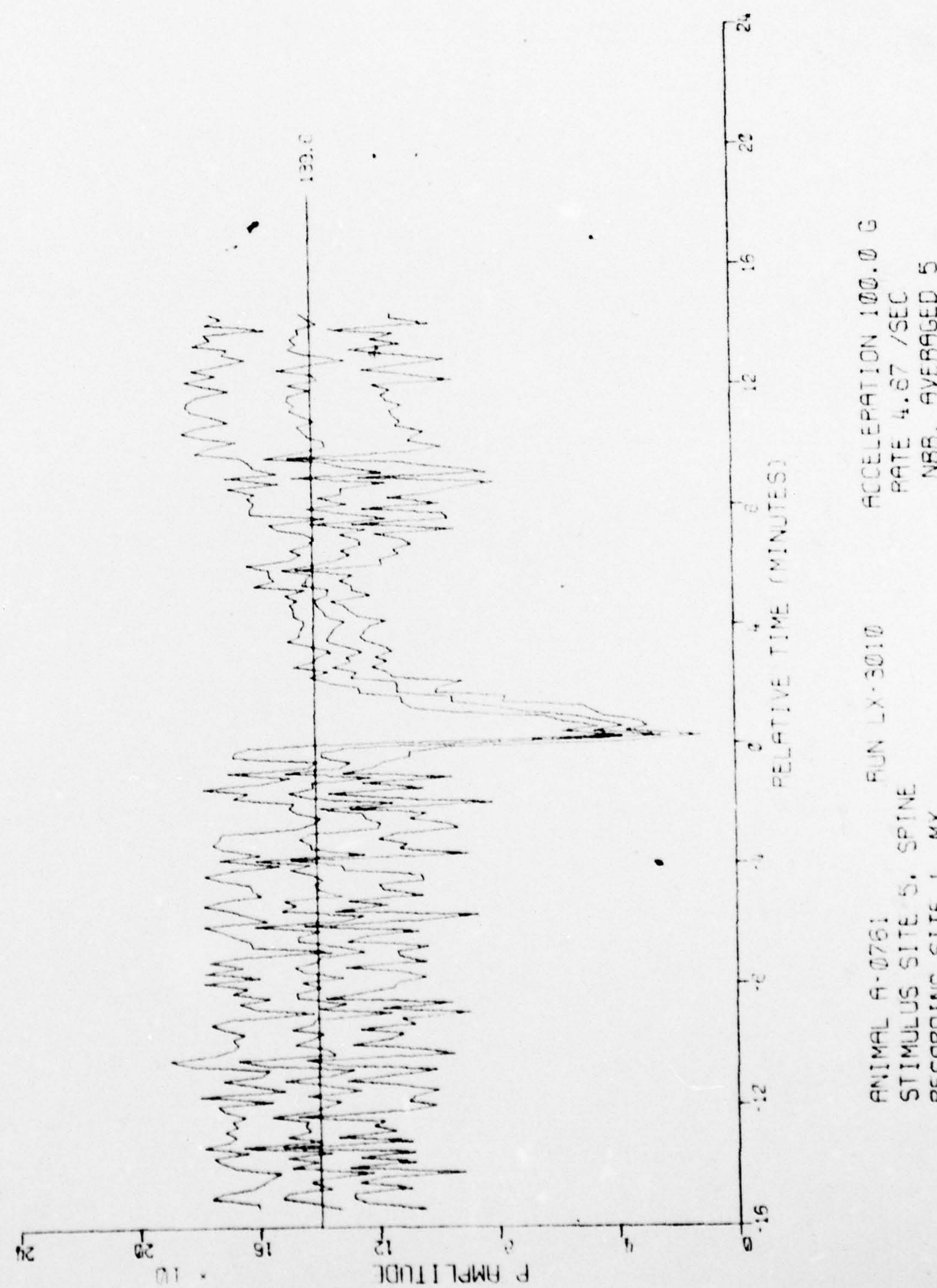

P AMPLITUDE × 10
RELATIVE TIME (MINUTES)
133.0
ANIMAL A-0761 RUN LX-3010
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
ACCELERATION 100.0 G
RATE 4.87 /SEC
NBR. AVERAGED 5

FIGURE D 28

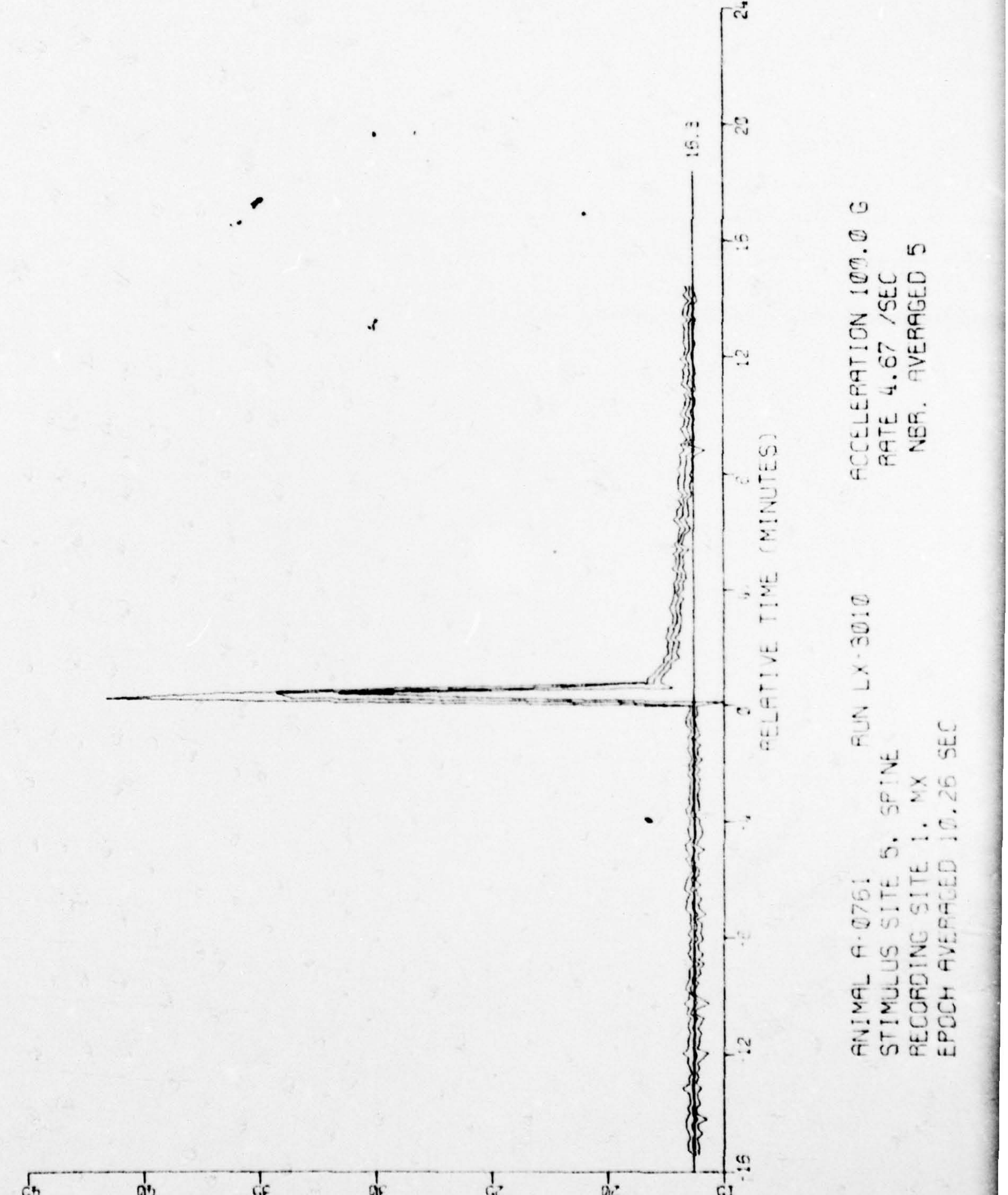

P LATENCY MSEC
15
20
25
30
35
40
45
-16
-12
-8
-4
0
4
8
12
16
20
24
RELATIVE TIME (MINUTES)
16.3
ANIMAL A-0761
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
RUN LX-3010
ACCELERATION 100.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 29

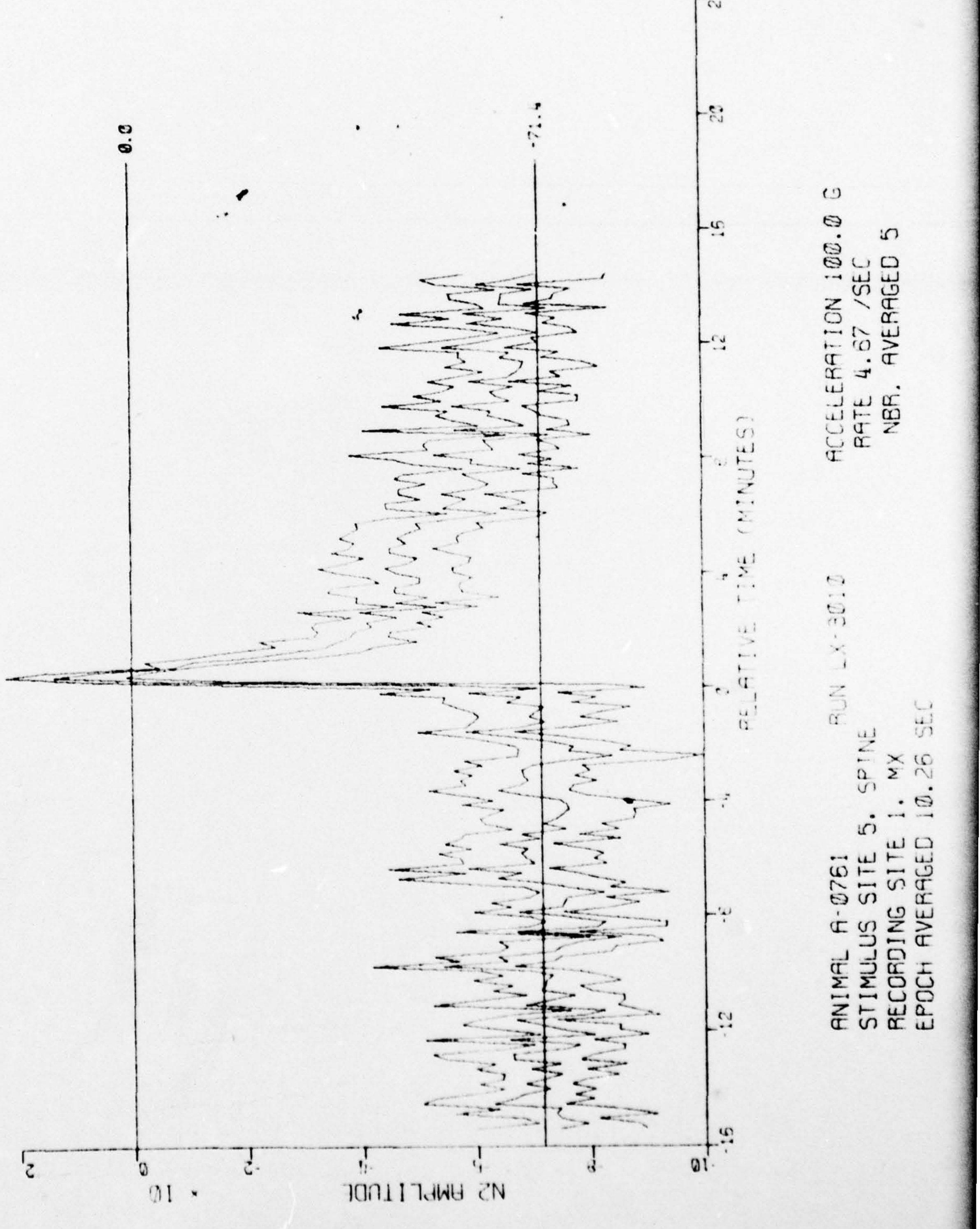

0.0
-71.4
N2 AMPLITUDE * 10
2
0
-2
-4
-6
-8
-10
-16
-12
-8
-4
0
4
8
12
16
20
24
RELATIVE TIME (MINUTES)
ANIMAL A-0761 RUN LX-3010
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
ACCELERATION 100.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 30

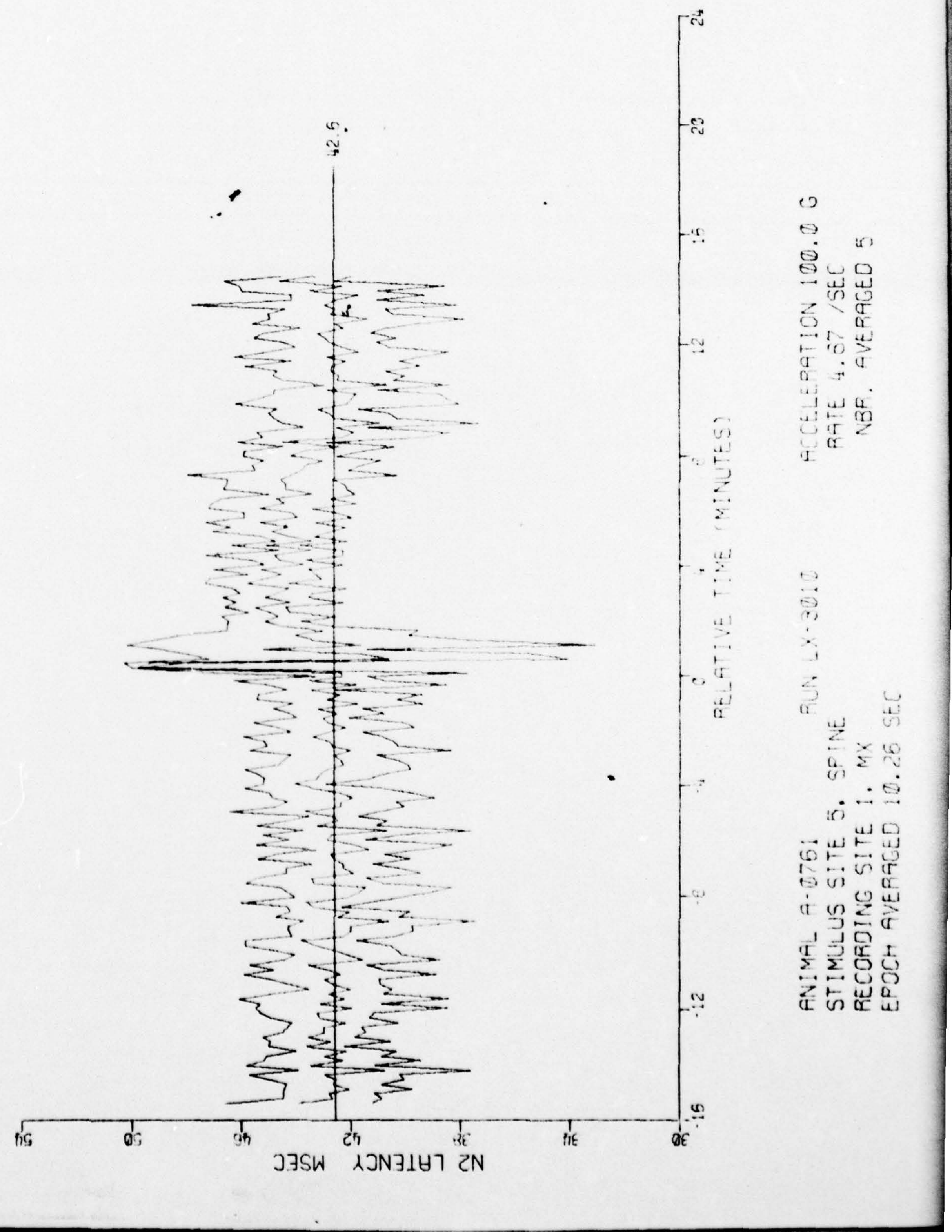
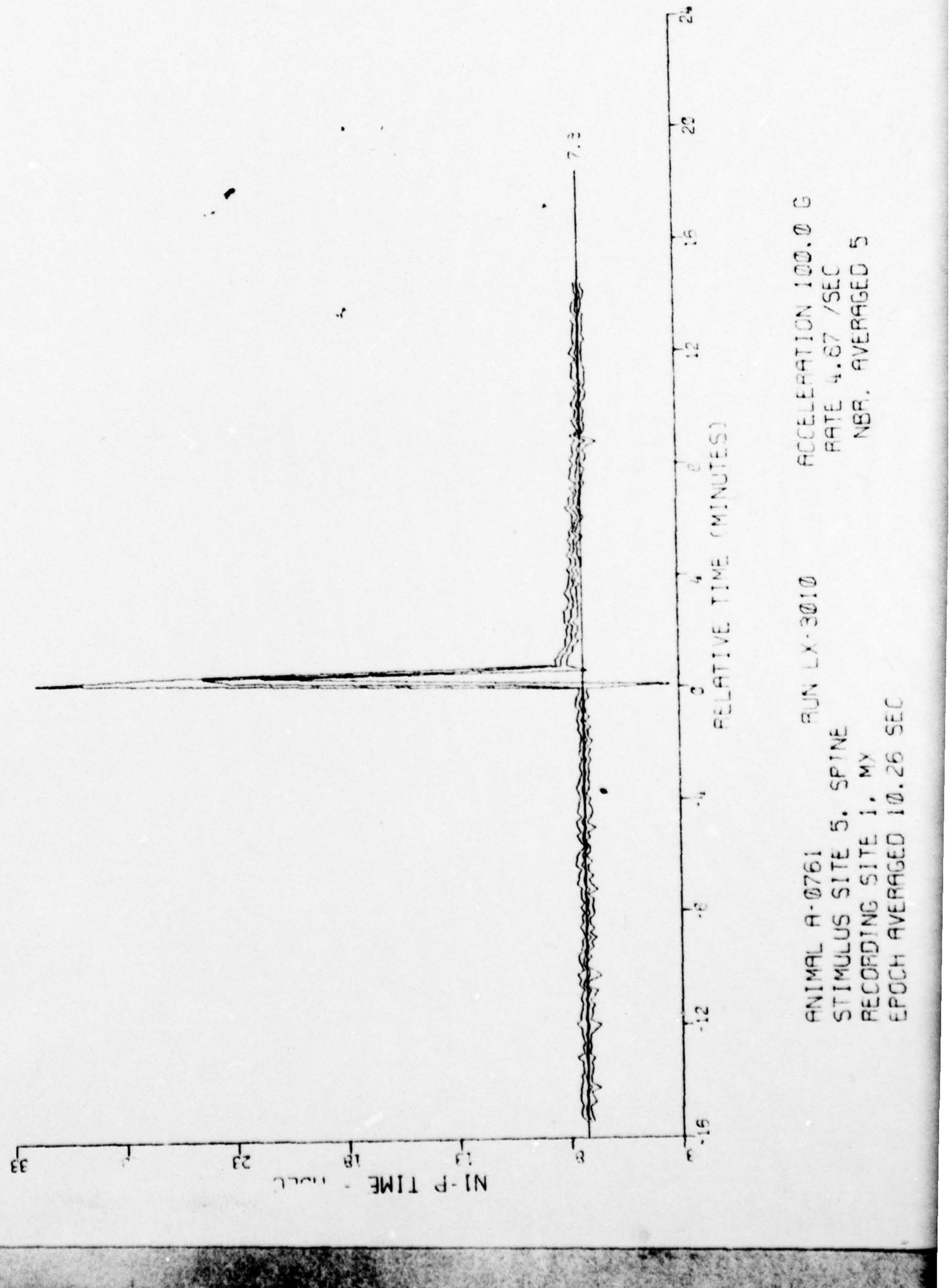
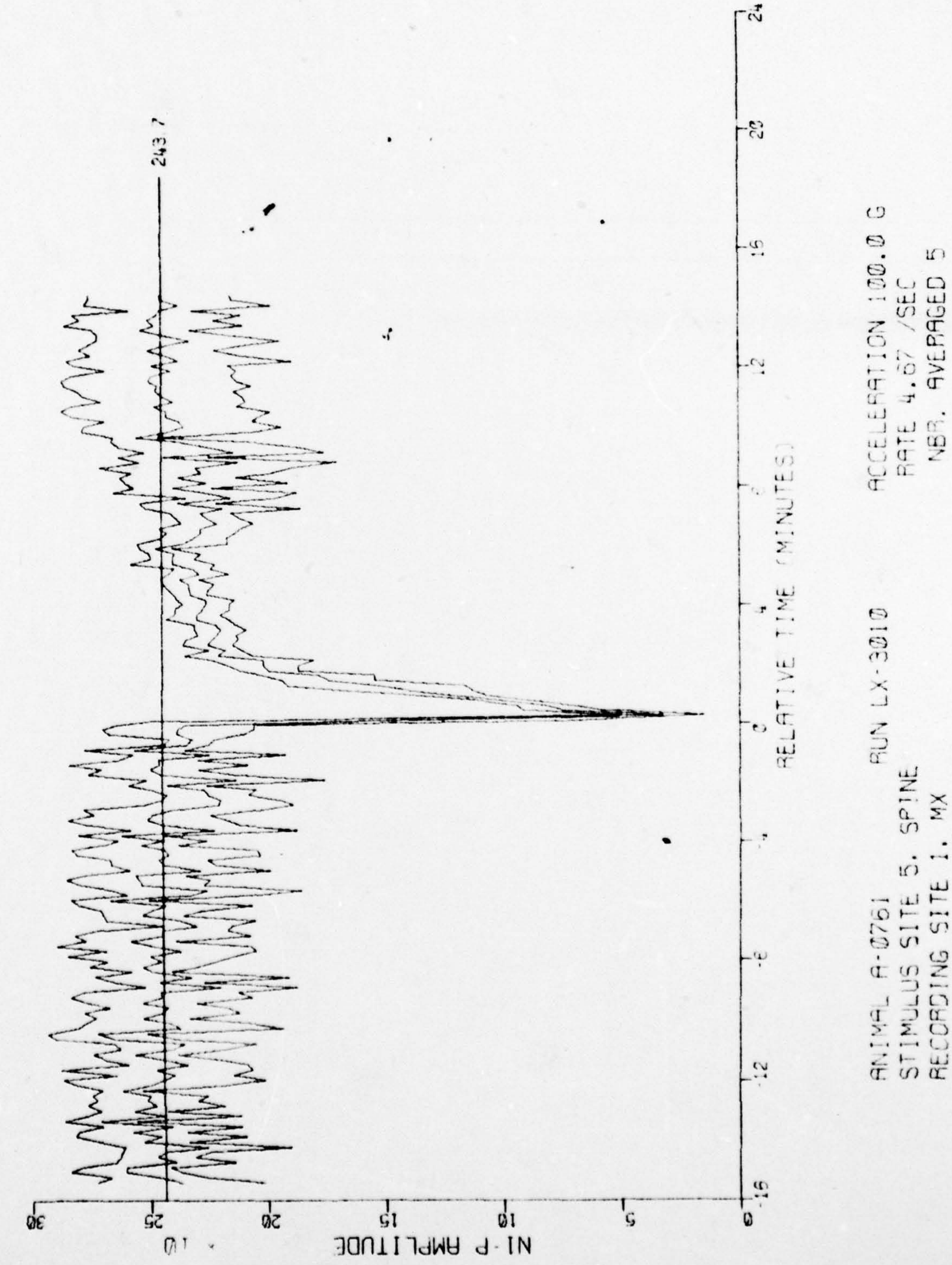

N2 LATENCY MSEC
30
34
38
42
46
50
54
42.6
-16
-12
-8
-4
0
4
8
12
16
20
24
RELATIVE TIME (MINUTES)
ANIMAL A-0761 RUN LX-3010 ACCELERATION 100.0 G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 31



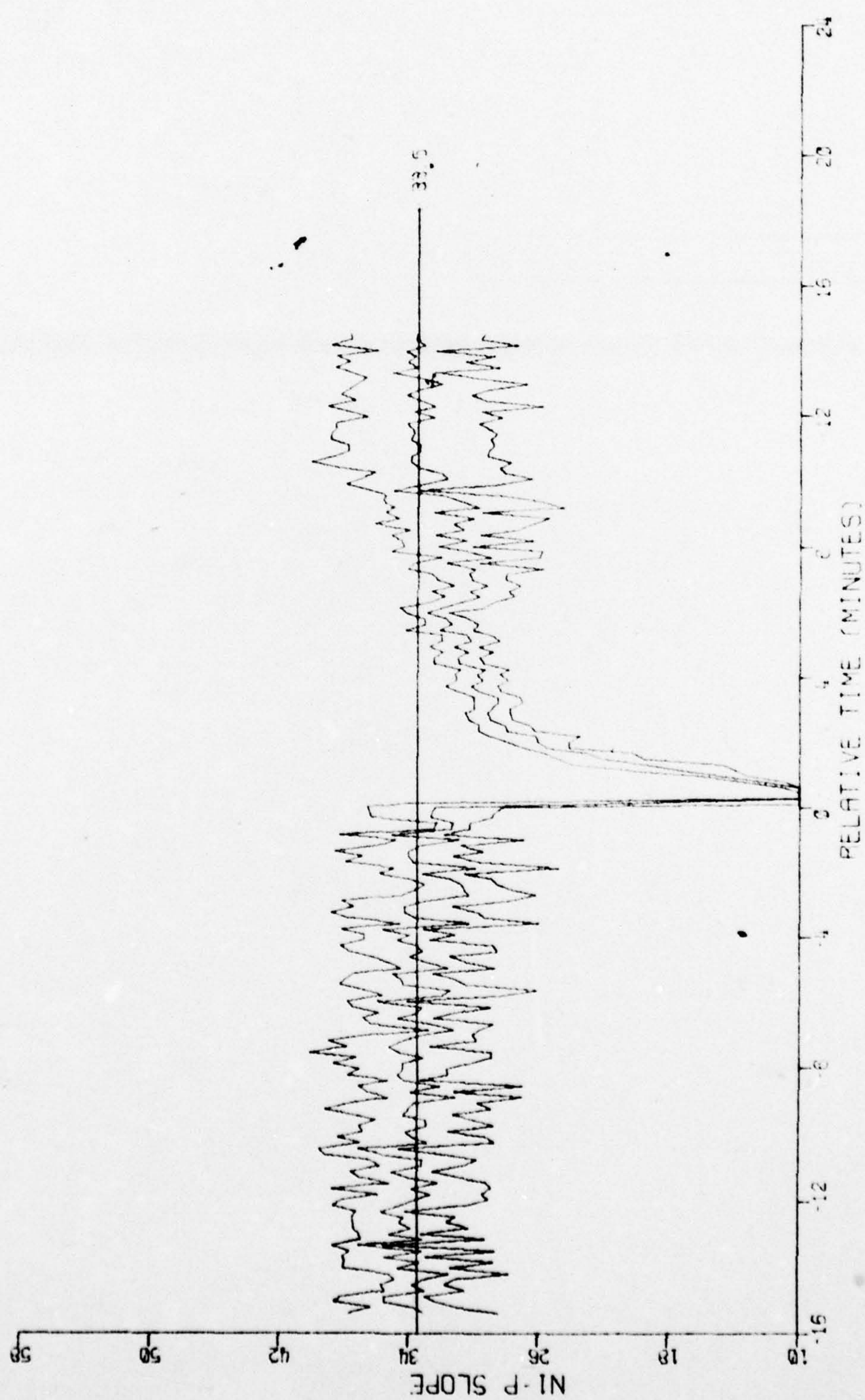
ANIMAL A-0761
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MY
EPOCH AVERAGED 10.26 SEC
RUN LX-3010
ACCELERATION 100.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5
RELATIVE TIME (MINUTES)
N1-P TIME

FIGURE D 32



NI-P AMPLITUDE x10
0
5
10
15
20
25
30
243.7
-16
-12
-8
-4
0
4
8
12
16
20
24
RELATIVE TIME (MINUTES)
ANIMAL A-0761
RUN LX-3010
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
ACCELERATION 100.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5

FIGURE D 33



ANIMAL A-0761 RUN LX-3010 ACCELERATION 100.0 G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 34

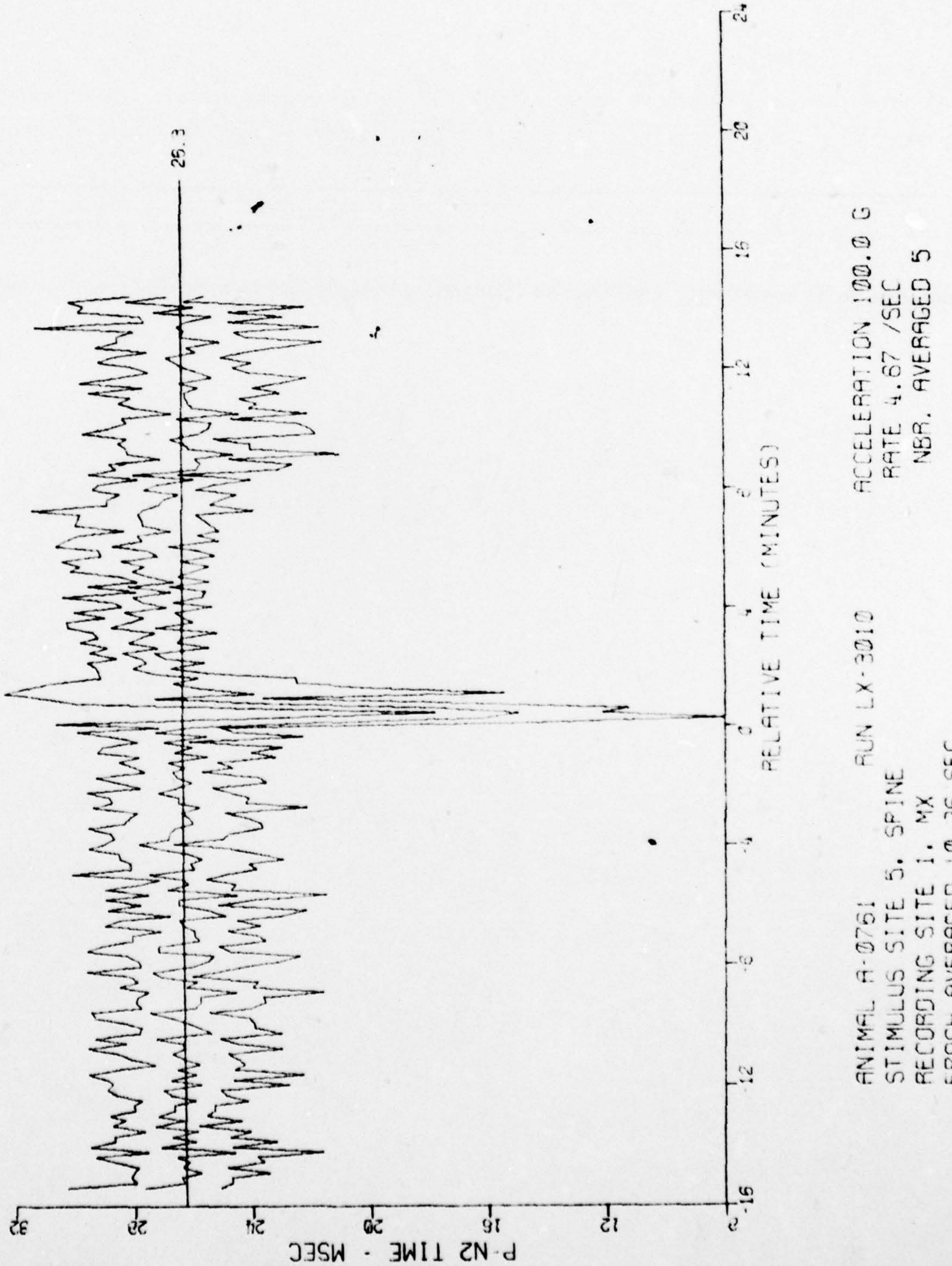

25.3
P-N2 TIME - MSEC
0
12
16
20
24
28
32
-16
-12
-8
-4
0
4
8
12
16
20
24
RELATIVE TIME (MINUTES)
ANIMAL A-0761 RUN LX-3010 ACCELERATION 100.0 G
STIMULUS SITE 5. SPINE RATE 4.67 /SEC
RECORDING SITE 1. MX NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 35

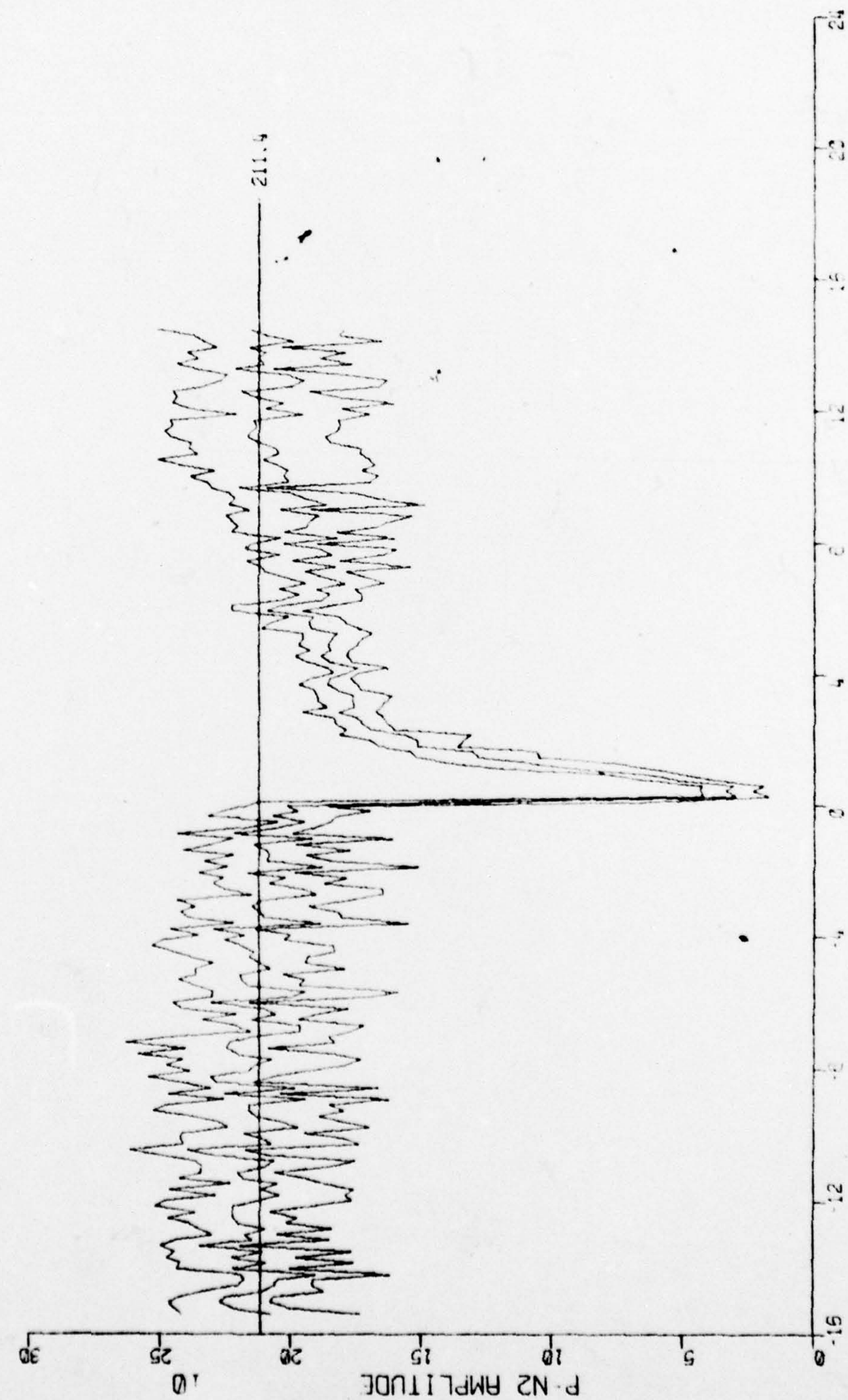
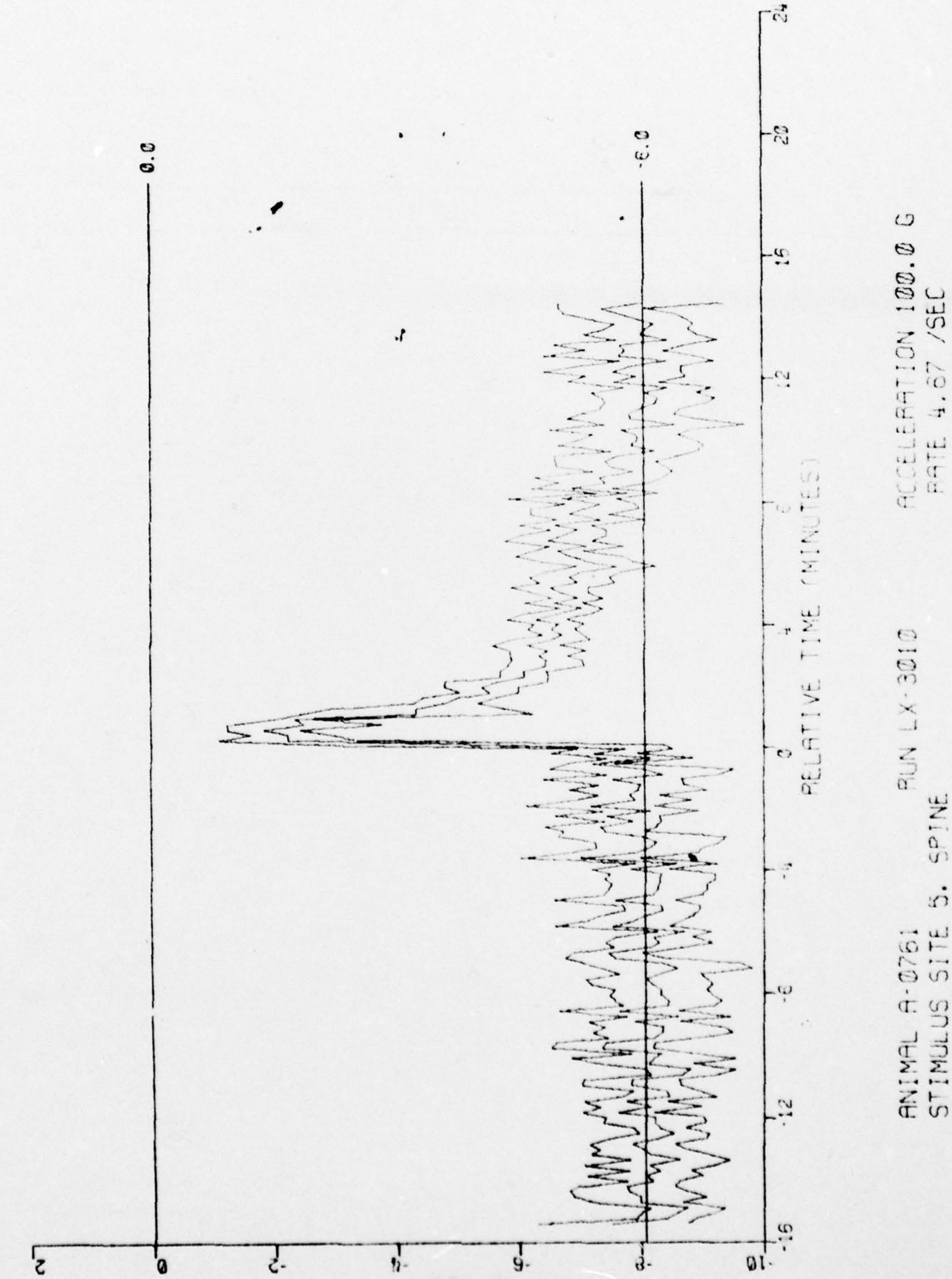

P-N2 AMPLITUDE
10
30
25
20
15
10
5
0
-16
-12
-8
-4
0
4
8
12
16
20
24
211.4
RELATIVE TIME (MINUTES)
ANIMAL A-0781
RUN LX-3010
ACCELERATION 100.0 G
STIMULUS SITE 5. SPINE
RATE 4.67 /SEC
RECORDING SITE 1. MX
NBR. AVERAGED 5
EPOCH AVERAGED 10.26 SEC

FIGURE D 36


P-N2 SLOPE
RELATIVE TIME (MINUTES)
0.0
-6.0
ANIMAL A-0761
STIMULUS SITE 5. SPINE
RECORDING SITE 1. MX
EPOCH AVERAGED 10.26 SEC
RUN LX-3010
ACCELERATION 100.0 G
RATE 4.67 /SEC
NBR. AVERAGED 5